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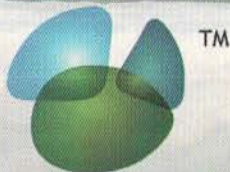
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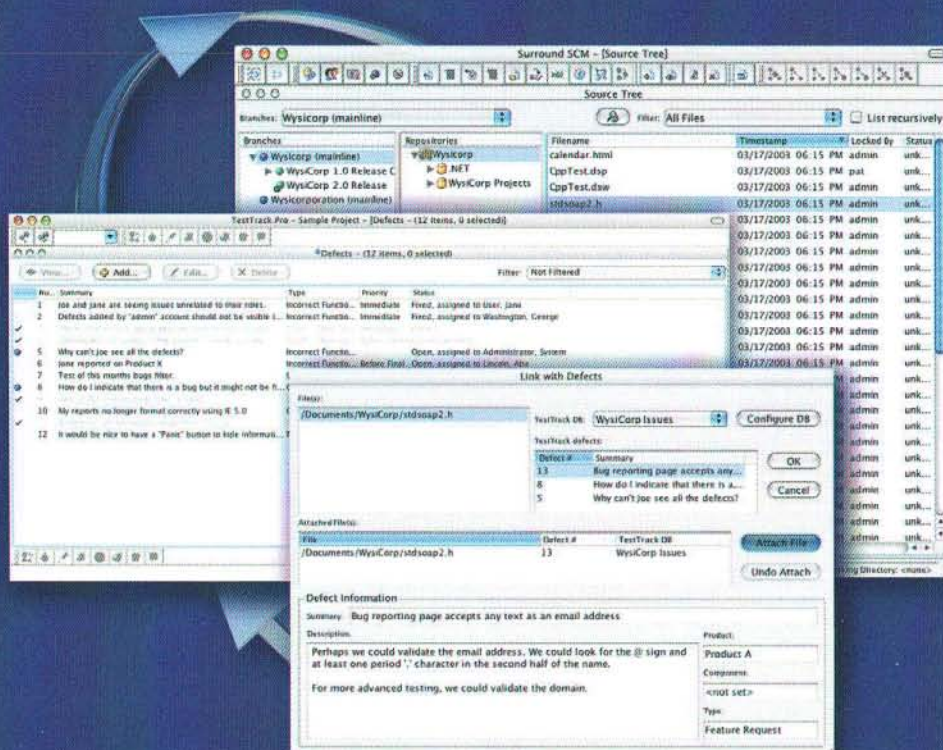
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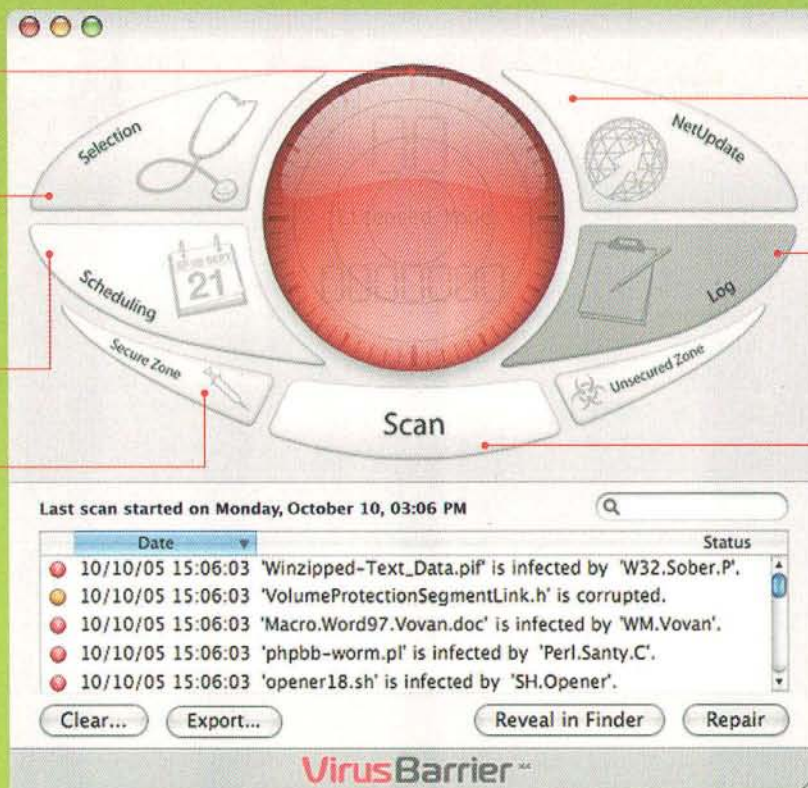
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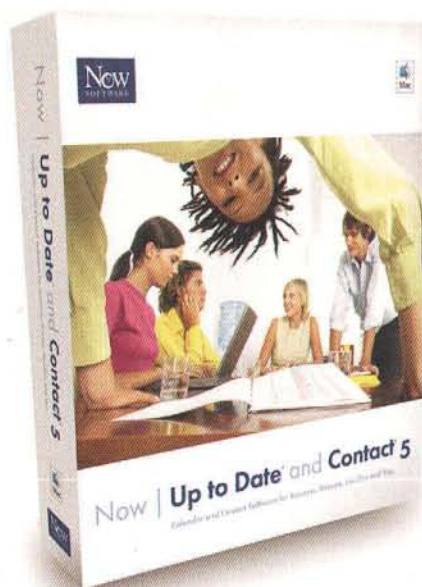
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The Journal of Macintosh Technology

A publication of **XPLAIN** CORPORATION

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MacTech Magazine (ISSN: 1067-8360 / USPS: 010-227) is published monthly by Xplain Corporation, 850-P Hampshire Road, Westlake Village, CA 91361-2800. Voice: 805/494-9797, FAX: 805/494-9798. Domestic subscription rates are \$47.00 per year. Canadian subscriptions are \$59.00 per year. All other international subscriptions are \$97.00 per year. Domestic source code disk subscriptions are \$77 per year. All international disk subscriptions are \$97.00 a year. Please remit in U.S. funds only. Periodical postage is paid at Thousand Oaks, CA and at additional mailing office.

POSTMASTER: Send address changes to **MacTech Magazine**, P.O. Box 5200, Westlake Village, CA 91359-5200.

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AWK FOR DATA PROCESSING - PART 2

REVIVING UP THE ENGINE.

Last month, I introduced you to awk, the 'pattern processor'. That laid the foundation, and merely scratched the surface of awk's power. This month, we're going to dive back into flow control, as we've seen with bash, sed, math routines, and other cool awk features. Of course, awk only becomes more powerful when combined with shell scripting and sed.

Pattern Matching

Now that, over the last few months, we've covered regexp, sed, shell globbing, and now, awk, here's a word on anytime you want to use a utility that does pattern matching. Sometimes you're not in control of the data you're going to need to sift through. However, there are times where, *you* are the one generating the data. This could be in the form of a report, or even from another command-line tool. In any case, try to make your life easier: don't spew out unnecessary data! For example: you may want to find out ip addresses assigned to a particular interface, so you decide to use `ifconfig`, and write a `sed` script to parse the output. The `sed` script can pattern match the interface and then loop through the results looking for "inet". Not bad, but you decrease your work if you specify the interface you're looking for to `ifconfig`. If you're using `nireport`, make sure you output fields in the order that you want them, rather than use awk to swap them around. If you need a file listing, look at all of the switches that will sort and add symbols to the output that will make matching easier. Always make sure you read man page for any program that you're using: you may find some surprising switches that reduce the work you do further down the chain.

Back to Basics

Part 1 of this article gave us some real awk basics – print, match a pattern, field operators and some built-in variables. The built-in variables that we covered were `NF`, the number of fields in a record, and `FS`, the field

separator. Of course, there are some more built-ins that we should know about. Let's do that before proceeding.

`FS` separates fields during the input stage. By default, awk separates output with a space. You can define that to be anything you want, using `OFS`. The output field separator is generated by the comma in a print statement. So, to rewrite an example from last month, we can make the output look better:

```
$ ls -l | awk 'BEGIN {OFS="\t\t"} {print $5,$9,$11}'
total
182468      20050629-local.jpg      -rw-r--r--
51986      iChats      drwxrwx--
68      images      drwxr-xr-x
1345      jamlog.txt      -rw-r--r--
61440      lads.exe      -rw-r--r--
271103      mount-1.260-3.wbm.gz      -rw-r--r--
352457      mr.spx      -rw-r--r--
```

Figure 1 - Output Field Separator in action

Better, but still a little ragged. Don't worry! We'll fix that in a bit.

When you generate multi-line output, awk separates each record with `ORS`, the record separator. `ORS` is a newline by default, so each record starts on a new line. You can change this! Why would you want to? You can even define `RS`, the input record separator. Sometimes, small examples are worth 1,000 words. If you are processing data that comes in a 'block' – spread out over several lines – setting `FS` to `"\n"`, the newline character, will allow awk access via the field variables. Set `RS` to `" "`, and awk will split these correctly when you have multiple input records. Practical example: you suspect a problem with user records, and want to search for particular users that (may) have the same home directory assigned. Here's the script:


```
01. #!/bin/bash
02.
03. for name in `dscl localhost -list /Search/Users`
04. do
05. dscl localhost -read /Search/Users/${name} | awk 'BEGIN
(FS="\n"; RS="") $0 ~ /\Users\/marczak/ {print $0}'
06. done
```

Figure 2 - User search script

First, you can see it's a shell script. We'll use bash to feed awk multi-line records using dscl. Line 3 sets up a loop using all of the usernames that we have access to. Line 5 uses dscl again to get the detail for the username provided and feed that record to awk. Using a BEGIN construct, we first set FS and RS. Then, we look for "/Users/marczak" *anywhere in the record* using \$0. If we match, we print the entire record. This way, we'll print all records that have that path as a home directory. It's a fairly specific example, but actually came in handy once. Plus, it illustrates handling multi-line records!

Finally, in our built-in round up, NR and FNR, keep the current line number available for you. NR is cumulative, and FNR gives you the number of the current record with respect to the input file. Useful if you're processing multiple files.

Low-level Format

awk is a fantastic tool for generating reports, however, reports are only really useful if they *look* good. The data can be good, but if it's hard to read, the brain just switches off. As you've seen, OFS and print only get you so far. awk supports a formatted print statement, printf, that you may have seen in some other languages, notably C. printf is more flexible than standard print, but requires a little more hand holding. Want an example? Here you go:

```
awk 'BEGIN {printf ("This is a test.\n")}'
```

Easy, right? So, what's different? First, you'll notice that you have to supply the newline – just like C! What I left out here, are the optional *format specifiers*, which again, match their counterpart in C. man printf will get you the list, if you forget them. Let's learn by example. The file listing code can be re-written with printf like this:

```
ls -l | awk '{printf "%s\t\t%s\t\t%s\n", $5, $9, $1}'
```

This means, print a string ("%s"), two tabs ("\t"), a string, two tabs and a string, followed up by a newline character. Each format specifier needs a corresponding value after the format string to fill in the place-holder with. We're substituting each %s with a field - \$5, \$9 and \$1, respectively. However, this really is the equivalent of the earlier code – it's *still* ragged! printf also allows you to supply the width and alignment of the output. So, to clean up our listing, we can use this:

```
$ ls -l | awk 'NR > 1 {printf "%-20s%-20s%-20s\n", $5, $9, $1}'
306          dist          drwxr-xr-x
42364        httpd.conf    -rw-r--r--
```

```
37417        httpd.conf.bak    -rw-r--r--
38334        httpd.conf.default -rw-r--r--
38334        httpd.conf.dist   -rw-r--r--
12965        magic            -rw-r--r--
12965        magic.default     -rw-r--r--
15201        mime.types        -rw-r--r--
15201        mime.types.default -rw-r--r--
204          users            drwxr-xr-x
```

Figure 3 - Width specifiers

That's much nicer! Explanation: instead of "%s", we can specify a width using "%20s" – "20" being the width. By default, the output is right justified in the space allotted. I added the hyphen – "%-20s" – to our example, to left justify the text.

Flow Control...Again

Depending on how long you've been reading this column, you've seen this before: we've covered looping and decision-making in bash and in sed. Well, flow is important! So, let's see how awk handles these constructs.

The most basic of tests is an if/then test. The pattern matching we've seen is essentially an if/then test that is applied to all input. However, if you've matched something basic, and then need to make further decisions, you can use if/then. Let's combine this with an example using a loop.

As you may have seen in other languages, awk has a while loop that conditionally executes a block of code. Here's the idea:

```
while (condition is true) action
```

Like other languages, you can have a line feed between the condition and action, and if the action is multiple lines, they must be contained in curly-braces. I'm actually going to throw a few new things in, and then explain. Let's re-write our user search script from earlier (Figure 2):

```
01. #!/bin/bash
02.
03. for name in `dscl localhost -list /Search/Users`
04. do
05. dscl localhost -read /Search/Users/${name} | awk '
06. BEGIN {FS="\n"; RS=""}
07. $0 ~ /\Users\/marczak/ {
08. i=1
09. while (i<NF) {
10.     if ($i ~ /Dir/ || $i ~ /ID/ || $i ~ /Shell/)
11.         i++
12. }
13. }
14. '
15. done
```

Figure 4 - A while loop in action

Once again, this is a shell script that feeds full blocks of data into awk. The dscl statements on lines 3 and 5 are identical to the ones from the first script. Look how we break up the awk script across multiple lines from there. Line 5 ends with a single quote, which allows bash to treat everything up until the next single quote as continuous code. *Note the closing single quote on line 14!* Again, we're going to look for a match on the entire

input (\$0) – looking for “/Users/Marczak” again. If and when we find it, that’s where our adventure begins.

Line 8 initializes the variable “i” to 1. *Not* zero. We’re going to index through fields, and *don’t* need to check \$0 again! Line 9 shows off our while loop. As long as i doesn’t exceed the number of fields on the input record, we execute the loop. First time through, i=1, and we can use it to reference the first field of input (\$1). Line 10 – an if statement! Lovely! *If* we find that the field we’re currently looking at contains “Dir” or (“|”) “ID” or “Shell”, we print that field. Then, we increment i on line 11 so we don’t loop around forever – and, we reference the next field in the next iteration of the loop.

Really cool stuff here: using the built-in NF variable as a comparison in our while loop, using a variable for the field reference, using classic Unix utilities with OS X specific CLI programs....nice. In addition to a while loop, awk supports the familiar “for” and “do” loop constructs. And as you may have guessed, you may recognize them already.

A “do” loop is a variant of the “while” loop. Its main difference is that the action is always executed at least once. It looks like this:

```
do {
    action
} while (condition is true)
```

Need to see it in action? Here you go:

```
BEGIN {
    numMice = 5
    catTime = 3
    do {
        theCatIsAway++
        theMicePlay = numMice * theCatIsAway
        if (theCatIsAway > catTime) theCatIsAway =
0
    } while (theCatIsAway)
    print "The mice played " theMicePlay " days."
```

Figure 5 – An example do loop

Yes, it’s a completely contrived example so I could use “while the cat is away”...I needed to bring a *little* levity to this column. This example does illustrate a little math, though, which I haven’t explicitly covered.

The for loop borrows its syntax from C and should be pretty recognizable:

```
for (initialize; test conditions; increment) {
    actions
}
```

Rewriting the previous loop using for would look like this:

```
01. BEGIN {
02.     numMice = 5
03.     catTime = 3
04.     for (theCatIsAway = 1; theCatIsAway > 0;
theCatIsAway++) {
05.         theMicePlay = numMice * theCatIsAway
06.         if (theCatIsAway > catTime)
theCatIsAway = -1
07.     }
08.     print "The mice played " theMicePlay " days"
09. }
```

Figure 6 – an example for loop

Look at that for loop! It’s a thing of beauty! No, really...I’m serious! (Outside of the fact that it ruins my play on words). It lets you take care of everything you need for a loop. Note, however, that the increment happens *at the bottom of the loop*. This is important, and is the reason, we set theCatIsAway to -1 rather than 0 on line 6. Otherwise, our test would never be true, and we’d get caught in an infinite loop.

Once again, like other languages, awk lets us skip an iteration of a loop, or break out altogether. Inside of a loop, the break keyword breaks out of the loop, and ends it:

```
do {
    if (leaveLoopNow) break
    procedure_one(x,y,z)
    procedure_two(x,y)
    transform_one(x,y)
} while (x < currentThreshold)
```

In this example, if leaveLoopNow is true, execute the break statement and bail out of the loop – never to execute the remainder of the loop, picking up execution following the loop.

A less drastic version of break, is continue. A short example will make it clear:

```
do {
    if (notThisTime) continue
    checkVars(x,y)
    transform_one(x,y)
} while (x < currentThreshold)
```

Here, if notThisTime is true, we just go back to the top of the loop. But the loop *will* continue, as long as our condition is true.

There are also two flow-altering statements that affect awk’s entire flow – next and exit. The simpler of the two is exit. When awk encounters the exit statement, it jumps to the END rule. Of course, you don’t even have to *have* and END rule defined. In that case, the script just terminates. Note that exit can supply a value to use as awk’s exit code. Nice way to test success or failure in a shell script. exit without a value defaults to “0”. next transfers control back to the top of the script where awk will read the next record of input. This is useful in a few different situations. If you only want to process records in a file that has 5 fields, simply sue this rule:

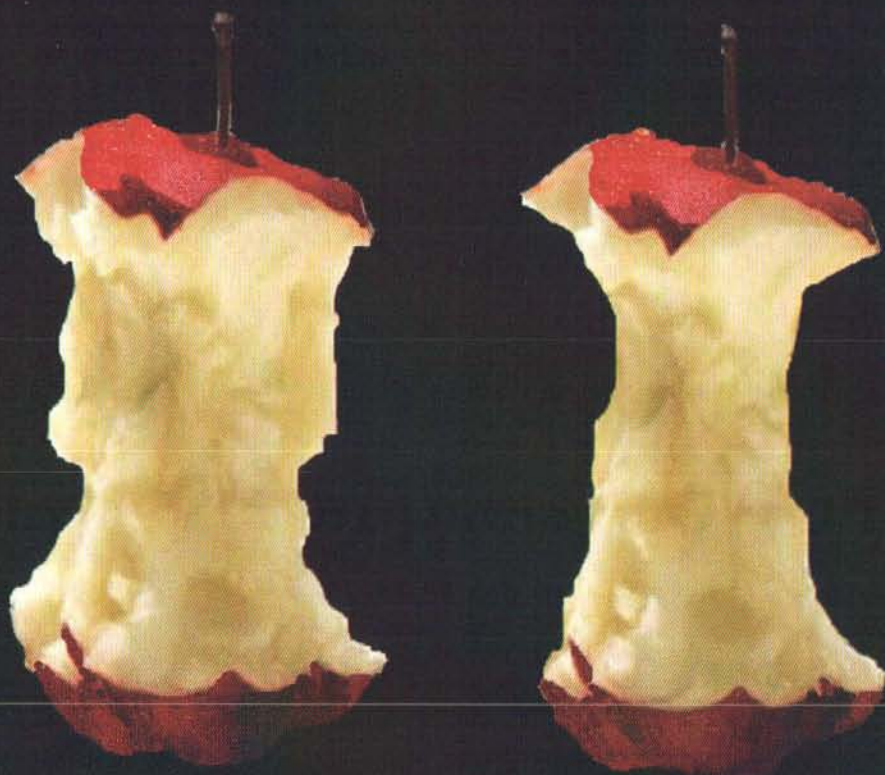
```
NF != 5 {next}
```

That’s also useful for error checking, whereby if the target input doesn’t ‘look’ right, you can just crank through the file. Perhaps even keeping count of how many records you skipped for use in an exception report.

Arrays

Here’s something that I can’t tell you I’ve covered before. Certainly not in sed, nor in bash. Of course there are other languages that support arrays, so some of this may look familiar. But, if this column has been your introduction to anything remotely related to programming or scripting, this will be slightly new. An *array* is simply a variable that lets you hold a series of

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values. Being a loosely typed language, all arrays in awk are *associative arrays* – arrays that map keys to values. Associative arrays do not need to use integers as the *key*, or *subscript*, nor does every value need to be of equal type and size. If you have a PHP background, you'll understand this innately. Naturally, examples are forthcoming. Like other variables in awk, arrays do not need to be declared, so you can just use them:

```
array[key] = value
```

Often, you'll see simple numeric keys (subscripts) – useful when loading data in from a file, and you want to track something from every record, or mark certain records based on a value. Just as often, though, you'll see a key; a string that maps to a value. We can use this feature like this:

```
BEGIN { color["red"] = "0xF00"
        color["green"] = "0x0F0"
        color["blue"] = "0x00F"

        print color["red"]
}
```

Nice, right? Arrays let us keep related values together. You can also use a variable as the key. Here's a totally trivial example that illustrates a few new concepts:

```
01. #!/bin/bash
02.
03. /System/Library/PrivateFrameworks/Apple80211.framework/Versions/A/Resources/airport -I | awk '
04. BEGIN { FS=":" }
05. {
06.   gsub(" ", "", $1)
07.   recordlist[$1] = $2
08. }
09. END {
10.   for (key in recordlist)
11.     print "The " key " is equal to" recordlist[key]
12. }
13. '
```

Figure 7 – Many new concepts!

Once again, I wrap awk in a bash shell script. First new thing, may be the `airport` command. With the `-I` switch, it gives you information about your current airport status. Next new thing is on line 5: `gsub`. Sometimes, exposure to many languages is a bit of a curse. When I see this command, I always think back to BASIC's "go sub" (*go to subroutine*) command. In awk's case, however, it stands for *global substitute*. I'm using it here just to clean up the output a bit. It's really powerful, though, and works like this:

```
gsub(regexp, substitution, string)
```

Now it's apparent; I'm just removing the spaces from \$1: a space (" ") is being replaced with nothing ("") in the string \$1. Now, look what's happening on line 6 – the value of \$1 is being used as the key in the array "recordlist". It's also being assigned the value of \$2, the second field. Then on line 9 in the END pattern, there's a new flow control statement. A variant on a for loop, we have some special syntax that accesses each element of an array in turn. "key" is a made-up variable. Right there, on the spot. It could really be whatever we like, but as with all variables, it should be

something somewhat meaningful. This variable will contain the current key name in each iteration of the loop.

While there's a lot more to arrays, I'd be remiss if I didn't mention two functions: `split` and `delete`. `split` splits a string into an array based on a separator. This is just like awk's main loop function that breaks input into fields based on FS. If you have awk reading a CSV file, you could use `split` thusly:

```
x = split($0, myFields, ",")
```

What this does is create an array – `myFields` – that contains each 'field' of \$0, fields being separated with a comma. `split` returns the number of fields in the string, in our case, putting the result into "x". If the input looked like this:

```
Mike Jones, 555-1234, mikej@example.com
Bill Smith, 555-0984, bills@example.com
Sally Foster, 555-3456, sallyf@example.com
```

...then during the first pass, `myFields` would contain:

```
myFields[1] = "Mike Jones"
myFields[2] = "555-1234"
myFields[3] = "mikej@example.com"
```

`split` is also a useful way to load up an array:

```
split("Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec", month, ",")
```

That's a lot easier than writing out `month[1] = "..."`

`delete` is simple: it lets you remove an element of an array. Simply:

```
delete myFields[2]
```

...would get rid of the phone number in our previous example. Of course, you can always just ignore a field, using `delete` will make sure it's gone if you choose to use `for...in`.

Grab Bag

There are some final things I feel the need to mention about awk, but realized that they're each pretty short and belonged altogether in a 'grab bag' section. Without further ado, here they are.

In addition to the other built-in variables that we've covered, awk presents two built-ins as arrays: `ARGV` and `ENVIRON`. `ARGV` is an array that contains each command line argument, including the script name itself in `ARGV[0]`. If you ran your script like this:

```
$ awk -f argvtest.awk var1 15 "Iolo" "Shamino"
```

...`ARGV` would contain:

```
ARGV[0] = awk
ARGV[1] = var1
ARGV[2] = 15
ARGV[3] = "Iolo"
ARGV[4] = "Shamino"
```

`ENVIRON` maps current environment variables to their values. For example:


```
print ENVIRON[OSTYPE]
```

on my machine would yield "darwin8.0".

In addition to `split` and `gsub`, `awk` contains some really useful (and common to other languages) string manipulation functions, such as `substr`, `toupper`, `length` and `tolower`. Consider that homework.

Finally, `awk` provides a way to get input outside of the main input loop. `getline` gets a new line of input, and can be used in two different ways. First, when used by itself, it will get the next line from input that the main loop would have gotten. This is similar to `next` (covered above), however, `getline` does *not* bring flow back to the top of the script. Secondly, you can pipe input into `awk` and read it with `getline`. While more in-depth work still requires a shell script, this is my favorite way to write a quick-and-dirty `awk` script. One example will get you going:

```
$ awk 'BEGIN {"top -l 1" | getline; print $2 " processes
running"}'
121 processes running
```

The output of `top` is piped into `awk` – directly from inside `awk`! You can, of course, even use that trick conditionally, and go look something up on the fly if needed.

Conclusion

To show *everything* that `awk` is capable of would take a book. I believe I've shown things that are immediately

understandable *and* practical. Between this column and the last, you should have a good foundation to build on. Of course, there's a lot more to explore. I didn't get to multi-dimensional arrays, trig math, user-defined functions, piping to output...and more. If this has whetted your appetite, there are many resources that teach `awk` in-depth. Just dropping into Google and trying "learning `awk`" brings back an incredible number of resources.

`awk` is a fantastic utility that has proved its worth over decades of classic Unix use. For OS X administrators, it dovetails perfectly with the powerful command-line utilities at our disposal.

Recommended reading for the month: *Cuckoo's Egg*, by Cliff Stoll. Released in 1989, this was one of the first track-a-hacker books I ever read. Of course, I could suggest some technical reference for you to dig into, but this is just good reading. I saw a copy at a bookstore not too long ago, and that made me break out my old version. Still a good read today, if not a great way to compare and contrast the technical environment of the late 1980s to today. Also, a good reminder that social engineering is timeless.



About The Author



Ed Marczak owns and operates Radiotope, a technology consulting company. More tech tips at the blog:

<http://www.radiotope.com/writing>

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Chances are that if you are even remotely involved in network security you will have heard about *VPNs*—Virtual Private Networks. According to the Gartner Group, it's one of the fastest growing segments of the IT industry and is predicted to reach almost \$6 billion in sales in 2006. That's pretty impressive when you think about how the markets have been doing lately.

VPNs were created to address two different problems: the high cost of dedicated leased lines needed for branch office communications and the need to allow employees a method of securely connecting to the headquarters' network when they were on business out of town or working from home.

In Part 1 of a 2-part article, I'll discuss what constitutes a VPN and how it works. I'll also look at some of the different VPN technologies and how they might for you. Part 2 will get very technical and dive into how Mac OS X implements VPN technology.

Public versus Private Networks

Before VPNs, if a company wanted to have a secure network connect to an office in another geographic location, they only had one choice: a dedicated leased line. This was a physical phone line laid between the two offices and the only connections allowed on it were the two ends of the networks. No one could dial in to the network and you had to have physical access to the line to be able to connect. Leased lines had two major disadvantages—they were very expensive (T1 leased line prices typically range from \$499 to \$1250 per month) and they could be very slow. If a company had a lot of different offices to connect, the costs would soon reach astronomical levels.

When the Internet became available for public use, companies quickly discovered that they could use that network to connect to their various locations. But, the Internet is a public network, is not secure, anyone can connect to it, and once upon a time had reliability issues for businesses. Also, anyone who has the right kind of software can easily eavesdrop and capture as much traffic on the Internet as they want. While Internet connections are fast and cheap, that's not necessarily the best solution for most companies who want to share private data securely.

The other impetus for the development of VPNs came from the need for employees who work from home, or who are on the road, to securely access their company's network. They could direct-dial in to the network, but it was quite easy for hackers to discover these phone numbers and use them themselves. In other words, dial-ins were not very secure. These employees

could possibly use the Internet to access their company's network but, again, that's not very secure.

So, you have the private networks that are expensive and slow and the public networks that are cheap and fast. Where was the happy medium? The answer was to use the public network—the Internet—but to hide the traffic so others on the Internet couldn't see it. This meant encryption. Encryption is the jumbling of data using specific mathematics—in other words, it's written in secret code. Of course, other users on the Internet can still see the encrypted traffic, they just can't tell what it is because it looks like garbage. No hacker in his right mind would go to the trouble to grab encrypted traffic, spend vast amounts of computing resources to decrypt it, to only discover he grabbed an email that says, "Hi, Mom!" Problem solved. Well, not totally...

What Makes A VPN?

A prototype of a VPN was Microsoft's first *RAS* (Remote Access Server) system. It was only used on NT-based systems and allowed remote users to dial in via modem. The difference from other dial-in systems was that RAS encrypted the session. It has its share of weaknesses, including a protocol that was not very secure, and the passwords could be easily cracked. Microsoft still offers RAS services on its servers, but it's not really considered to be a "true" VPN.

To be considered a "true" VPN nowadays, the service must support the following:

- **Data Protection**—the data traveling on the public network (Internet) must be unreadable by unauthorized users on the network.
- **User Authentication**—the VPN must be able to verify a user's identity and restrict access to only validated users. In addition, there must be a method of logging access.
- **Key Management**—the VPN must be able to generate shared, secret keys with the remote users.
- **Address Management**—the VPN must be able to keep the IP addresses of the internal network secret.
- **Multiprotocol Support**—the VPN must be able to handle multiple protocols so data of different types can be shared. This includes protocols like SMTP, HTTP, telnet, and so on.

From these requirements, three different types of VPNs have emerged:

- **Firewall-based VPNs:** All the VPN negotiations are handled by the firewall.
- **Hardware-based VPNs:** Generally, these are encrypting routers.
- **Software-based VPNs:** A complete package installed on a server, ideally dedicated to establishing and maintaining VPN connections.

So, How Does A VPN Work?

A VPN uses a special protocol to establish a virtual *channel* between two machines or two networks. Imagine if you could blow a soap bubble in the shape of a tube and only you and your friend could talk through it. The bubble is temporary and when you want to have another conversation, you would have to create another bubble. That's kinda like a VPN's channel. This channel is actually a temporary direct session. This is what is commonly referred to as *tunneling*.

Then the VPN also exchanges a set of shared secrets to create an encryption key. The traffic traveling along the established channel is *wrapped* with an encrypted package that has an address on the outside of the packet, but the contents are hidden from view. It's sort of like a candy wrapper. You can see the candy, but you don't really know what the candy looks like on the inside. The same thing happens with the encrypted traffic. The original contents are hidden from view, but it has enough information to get it to its destination. Once the data reaches its destination, the wrapper is safely removed.

There are generally two different protocols in use for VPNs. *IPSec* (Secure IP) and *L2TP* (Layer 2 Tunneling Protocol). The main difference between the two is that IPSec does not have a way to create security keys and L2TP does. IPSec must be combined with another protocol like *ISAKMP* (Internet Security Association and Key Management Protocol) or *IKE* (Internet Key Exchange). This is not a problem since most vendors include all the necessary components within their products for a complete solution.

Here are the basic steps that happen during a VPN session:

1. The remote user requests a VPN connection.

This could be via a laptop with a dial-in through an ISP or via another computer connected to the Internet.

2. The destination point receives the request and establishes a temporary tunnel.

The destination point is now beginning to set up the VPN.

3. Both the remote computer and the destination share their keys and the destination network defines how the traffic will be encapsulated with encrypted wrappers.

Both of the keys had previously been created. They are encrypted and can't be understood by an eavesdropper.

4. The destination point sends a challenge to the remote user to identify himself.

This is similar to the Army lookout shouting "Halt! Who goes there?"

5. The remote user uses his UserID and password and whatever else is required (like a smart card or token) to authenticate himself to the destination network.

These steps will have been previously established when the VPN was first installed.

6. The destination network verifies the remote user and assigns a temporary IP address to the remote computer.

If the verification process is interrupted or if the remote user cannot be verified, the entire session is dropped and no more traffic is sent.

7. The encrypted communication channel is established.

Data now starts traversing the VPN.

L2TP versus IPSec

When deciding on a VPN, it's important for you to know the differences between the two main protocols used, otherwise you could end up with a VPN that doesn't really suit your needs. These main protocols were developed for different types of traffic.

L2TP emerged from the original *PPP* (Point to Point Protocol) that was used for dial-up connections. This was very popular because it allowed the transmission of non-TCP/IP protocols like IPX, AppleTalk, and NetBEUI. L2TP works at Layer 2 of the *OSI* (Open Systems Interconnection) model, which is the Data Link layer. Since it works at Layer 2, it does not use *packets* to transmit data, it uses *frames* instead. A frame is a much simpler construct than a packet and it does not have as much information in it as a packet has. For example, a frame doesn't have any information on error control. You can think of a frame as a burst of data rather than a package of data.

IPSec, on the other hand, works at Layer 3 of the OSI model, which is the network layer. This is the layer we are more familiar with since it deals with IP packets that have all kinds of information in them. A packet has been likened to an envelope—on the outside of the envelope are the to/from addresses and a small description of the type of data enclosed. Since IPSec can only deal with packets, it is limited to transmitting TCP/IP traffic. IPSec couldn't handle AppleTalk or NetBEUI network protocols.

Therefore, L2TP is better suited for VPNs for dial-up connections or networks using a variety of networking technologies like Frame Relay or ATM (Asynchronous Transfer Mode). IPSec is better if you have a straightforward IP-based network. On the other hand, many users combine both IPSec and L2TP on their VPNs for better security.

Setting Up A VPN

Not to oversimplify it, but there are two basic ways of setting up a VPN. The first way is normally used between networks and firewalls or encrypting routers to do the encrypting and decrypting of the traffic. In this setup there is no need for special software on the desktop or client computers. The second method is to have a firewall, encrypting router, or VPN server at the destination end and special VPN client software on the desktop or laptop computers. It all depends on whether the VPN is a two-way operation or a one-way operation.

You won't see the terms "one-way" or "two-way" in any of the vendor's technical data on VPNs. Those are my terms. In a two-way relationship, or network-to-network, you have two networks that want to work together and each has basically the same VPN setup as the other. The request to establish a VPN connection can come from either direction. No special software is needed on the desktop computers because all the encrypting and decrypting is done at the entry and exit points of the network. Both networks also have key management systems so they can both create secret keys for a VPN session. It's important that the two networks have compatible VPN components or they won't be successful in talking to one another.

In a one-way, or node-to-network, relationship, the destination network has the VPN setup and there is no agreement with another network to share. In that case, the computer wanting to make the connection with the network has to have VPN client software and the request can only be made

in one direction—from the client to the network. The client software can request and authenticate itself, but the secret key making mechanisms are only on the network. The client computer will have a secret key stored on itself, but it cannot create new keys.

Generally, the one-way system is used for remote users who are dialing in from home or while they are traveling on the road. They dial up through their ISP and the mechanisms for establishing and maintaining VPN connections is all contained at the destination network. If someone with a laptop with the VPN client software tried to connect to the company's network, he wouldn't get too far because he wouldn't have the client software or a secret key. Additionally, the unauthorized user would not be listed on the VPN's database of authorized users. However, once someone dials in and is authenticated, their access is the same as if they were sitting in the same building as the destination network, pending firewall rules, of course. Also, unlike sitting on the same network, typically, no broadcast traffic will pass over the VPN link, such as the broadcasts used for Bonjour.

Inside or Outside?

You can set up the VPN *endpoint* at various locations. The endpoint is where the VPN traffic comes into your network. In some cases the endpoint is also the firewall as many firewalls come with VPN capabilities nowadays. The endpoint can also be in front of the firewall, in a DMZ off one side to the firewall, or inside of the firewall. Each of these configurations has its pluses and minuses.

If you choose to put your VPN in front of the firewall, the mechanism does all of the encrypting and decrypting on its own. That means there is no need to allow an open VPN tunnel through your firewall. All of the traffic through the firewall will have been pre-filtered and formatted so the firewall can read it. However, if the VPN fails or is taken down, you'll be faced with a situation where all the traffic goes out unencrypted, or no traffic at all gets out. It depends on whether or not your VPN will fail in the open or closed position.

A VPN on the firewall would seem like a good solution because, again, you don't need to leave an open tunnel through the firewall. The firewall will handle all the encryption, decryption, and its regular job of the examination of traffic. This type of solution puts an enormous burden on the poor little firewall, though. You are asking this machine to do a hell of a lot of processing! Encryption and decryption is labor intensive for a computer, as is the examination of traffic and that could result in a bottleneck for traffic.

Another method is to put the VPN on the inside of the firewall. This relieves the firewall and/or the router of having to handle the encryption and decryption of the traffic, but you have to allow a VPN tunnel to pass through the firewall. A firewall cannot read encrypted traffic and it will allow that traffic to pass through unchallenged. Of course, the traffic will still be stopped by the VPN mechanism, but by that time it is already in the internal network. [Ed. Note: this is such a horribly awful idea, we don't recommend it. Don't unnecessarily poke holes in a firewall!]

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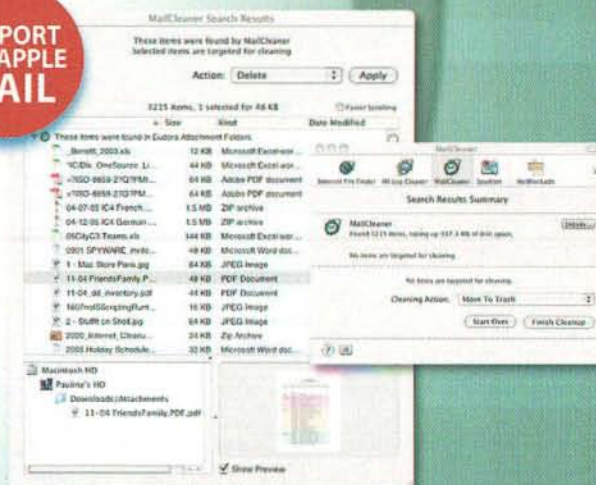
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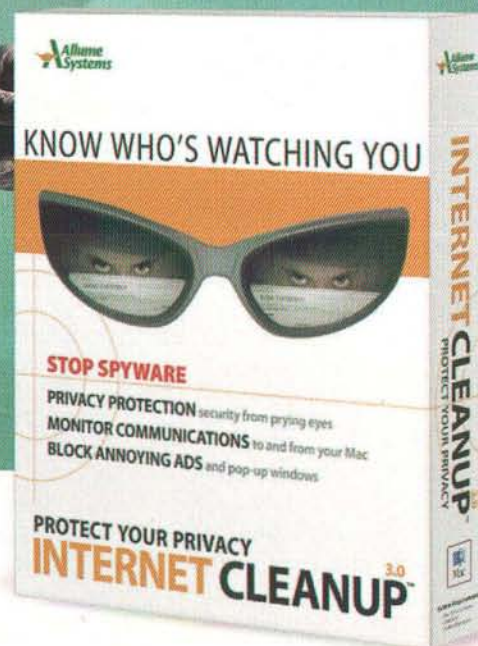
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Securing the Client

Probably the easiest way to break a VPN's security is to get a hold of a laptop that is used to dial in for a VPN connection. I know of more than one person who has had a laptop stolen from a rental car within hours of arrival in a new city. The stolen laptop will have the VPN client software, the UserID, and the secret key all stored on one machine. A smart laptop owner will not have saved the password for the VPN tunnel on his computer. If he has, the thief has just gotten himself a free ticket to wander around in your network!

Users who use laptops to establish VPN connections with your network need to be given lessons in maintaining good security. They should have up-to-date anti-virus software installed and ensure that it runs very every time they start the computer. Anti-virus software is good at detecting Trojan horses that could be used to hijack or piggyback a VPN session. Additionally, the laptop should have personal firewall software set up. Some VPN client already include personal firewalls, so you'll have to check with your vendor as to whether yours does or doesn't. The personal firewall can ensure that only the VPN client is making the connection and that it's not actually a Trojan horse program masquerading as the VPN client. Another good precaution is to enable the BIOS/OF/EFI password. That way, if the computer is stolen, it cannot even be started up without the password.

It's a good idea to restrict remote VPN connections via laptop to those who really need it. You shouldn't be handing out this capability like candy to anyone who asks for it. Your employees should be able to present a good case for needing it or it just becomes another one of those bells and whistles that people like to have and brag about. Also, consider smart cards and tokens, such as those available from CRYPTOCARD <<http://www.cryptocard.com>>.

Some Terminology

You'll find that the term VPN means different things to different people—especially when it comes to vendors. However, the basic mechanisms that are generally agreed upon are encryption and authentication. Some vendors offer a “complete” solution and others only offer bits and pieces of the entire puzzle. You have to be determined and keep asking questions until you're sure you're satisfied with their answers. It's no disgrace to say you don't understand. In fact, if the vendor can't explain something to your satisfaction may be that he doesn't really understand it himself!

I have included some terms and expressions you may hear or read. Hope this helps!

- AES – Advanced Encryption Standard. The encryption algorithm used by the U.S. Government.
- DES – Data Encryption Standard. One of the cryptographic

algorithms used in encryption. A stronger version is known as 3DES (Triple DES).

- Diffie-Hellman – Another cryptographic algorithm used in VPNs.
- GRE – Generic Routing Encapsulation. A method of wrapping packets so that the original addresses are hidden.
- IKE – Internet Key Exchange. The protocol used for exchanging secret keys in IPSec.
- ISAKMP – Internet Security Association and Key Management Protocol. The forerunner of IKE.
- LDAP – Lightweight Directory Access Protocol. A set of protocols for computers to obtain information from one another, based on the X500 standard. In VPNs it is used for secret key information.
- MPLS – Multiprotocol Label Switching. Used to divert traffic when there are failures or bottlenecks in the network.
- Oakley – A protocol used for exchanging secret keys.
- PPTP – Point to Point Tunneling Protocol. A forerunner to L2TP.
- QoS – Quality of Service. The amount of traffic a VPN can handle and how well it handles the traffic.
- RADIUS – Remote Authentication Dial In User Service. An authorization system used to authenticate users.
- RSA – Rivest-Shamir-Adleman. A cryptographic algorithm for key exchange.
- SSH – Secure Shell. A secure form of telnet that encrypts the traffic.

Summary

This article on VPNs (Very Precious Network Security) introduced basic concepts, why they are used, and the variety of technologies involved.

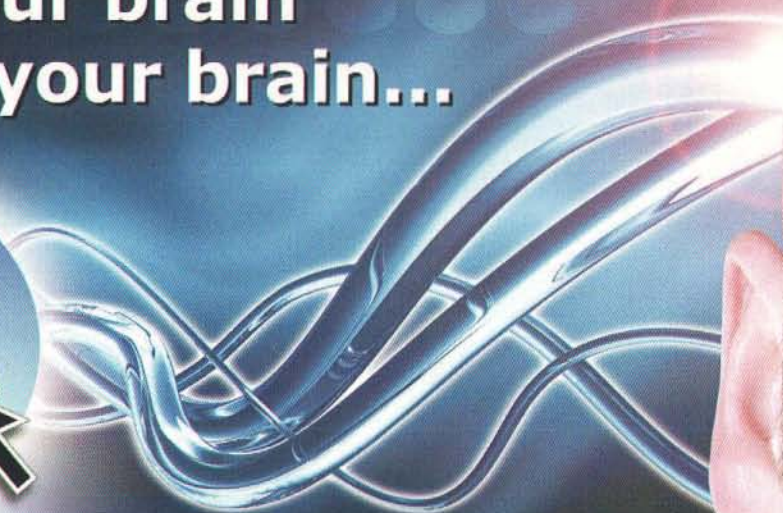
In Part 2, I will go deep into how Mac OS X implements L2TP, how it compares to other 3rd party solutions, and how to connect to a Linux L2TP/IPSec VPN Server.



About The Author

Paul T. Ammann has been working in IT for almost 20 years now. He is happily married to his wife Eve for 6 years. He finds writing the author's bio the toughest part the article. He can be contacted at pammann@spymac.com.

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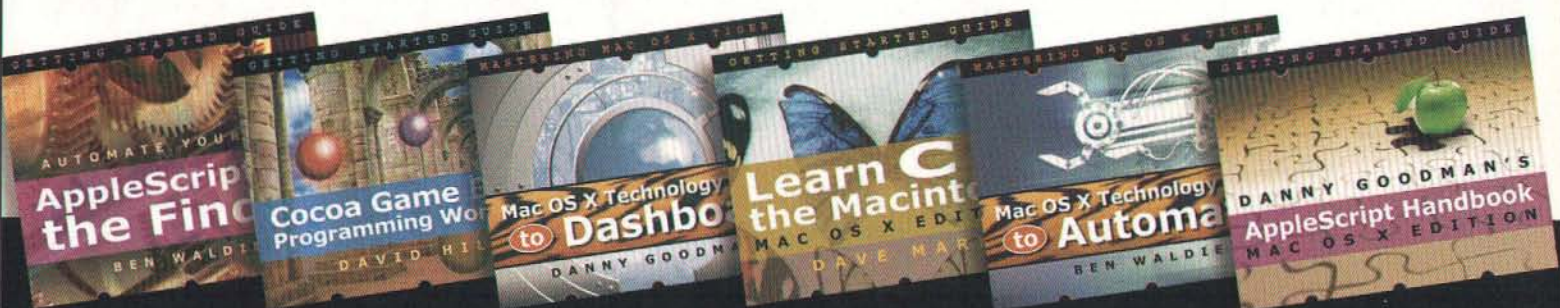


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Safeguarding "sensitive data" using encrypted disk images

By Aaron Adams

With Tiger's release, it's now easier than ever to keep your (imagine me making big finger quotes here) "sensitive data" secure. You know the "sensitive data" I'm talking about. The kind that's not intended for casual viewing. There's also the real sensitive data. Payroll records, bonus charts, proprietary data, your secret plan for world peace. It's only a matter of time until someone using a shared Mac performs an innocuous Spotlight search that suddenly turns up a cornucopia of sensitive data associated with you. Depending on who finds it, you could lose your job, lose business, lose your significant other, or just have more headaches than you really need. An ounce of prevention is worth a ton of cure.

Hiding such things from Spotlight is a good idea. To do that, you can create an encrypted disk image that is password protected to keep nosy users out. The contents of the image won't appear in Spotlight unless the image is mounted.

To begin, go to the /Applications/Utilities folder (press command-shift-u in the Finder) and start up Disk Utility. Click File, New, and Disk Image from Folder. This will create something called a sparse image. Sparse images are initially only as big as the data they contain, but have the advantage of expandability later.

Select the folder where your sensitive data is located and press the Image button. Name the image. Select read/write from the Image Format drop-down. Click the Encryption drop-down and choose AES-128 (recommended). Select a save location and press Save.

You will then be prompted for a password. This is the password Disk Utility will use to encrypt the data and that you will have to enter it each time the image is mounted. Do yourself a favor and make the password hard to guess. Do yourself another favor and **uncheck the box marked Remember password** (add to Keychain). It defeats the purpose of encrypting and

password protecting an image if you're going to automate its access with Keychain. Click OK after entering your new password. [Ed Note: Do yourself a final favor – make this password something different than your login password.]

A new disk image containing your data in encrypted form will be created. When you double-click the image to mount it, you will be prompted for the password. Drag and drop new sensitive data onto the image as desired for permanent safekeeping.

Over time, your collection will probably continue to grow and will become larger than the sparse image you just created. As I said before, sparse images can be expanded to any size you need, but the drawback is that you have to do it through the command line.

Open Terminal and enter this command:

```
hdiutil resize -size xxx /path/to/image.dmg
```

where xxx is the size you want to the image to be in megabytes or gigabytes. For example, 500mb or 4.7gb.

Now your sensitive data, or "sensitive data", is protected from prying eyes and accidental finds. Backups are a simple one-file copy operation. You stay out of trouble, off the unemployment lines, and in the closet. I love it when technology helps people.

MI

About The Author

Aaron Adams is a Mac consultant and network whipping boy located in Dayton, Ohio. You may also remember him from Apple's "Switch" campaign a few years ago. You can e-mail him at aaron@aaroadams.net.

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Building a Backup System on the Mac

By Neil Ticktin, Publisher/Editor-in-Chief

Unless you like tempting fate, or are a masochist, backups are a necessary part of any computer setup. Whether you have just one machine, or are in an Enterprise environment, you have to think about backups. There are a variety of reasons why you do backups. Sure, you may want to provide against the obvious hardware failure, but backups also give you protection against hackers, viruses, newly installed software, missing computers, and the ever-present user error.

There are a number of solutions for the home network or individuals that are out there, and there are high-end solutions for large networks and Enterprise environments. This article, however, talks about a multi-vendor approach that we took on a real world network.

There have been articles out there about what to do with your older machines, but we thought that we would take the approach of using a combination of existing hardware, upgrades and modern technology to create a solid backup solution for a small to medium size business.

Software, Media and The Test Scenario

We wanted to test our newly built system with a scenario that may be typical of many small to medium size businesses. In this scenario, we had one "main" location with about 15 machines, one satellite office with another 5 machines, and one telecommuter.

Many people today like backing up to a disk drive. It's fast. It's very reliable, and, disks are relatively cheap these days. I agree. In fact, we make sure that we have a clone of main web server's hard drive available at all times, so that it can be back up and running in no time. But one thing that hard drives don't do for you is give you "snapshots" in time which are the ultimate protection against viruses, hacking, newly installed software and user error.

If you want snapshots, as we do, then you need two things: software that does that for you, and a medium that supports it well. Some of the backup software out there does not support snapshots as completely as I would like, or is the wrong "size" of software, so we chose Retrospect 6.1 as our base. Furthermore, while we do have hard drives as part of our strategy, tape is our medium of choice simply because it's easy to have multiple sets of data (so that some are off-site and some are on-site). It's also very inexpensive for large volumes of data.

The main location has the largest data sets: databases, web sites, file servers, email, and the dedicated backup server. With remote locations backing up to the main

location, we wanted to have dedicated hard drives in the backup server that would be available 24/7 and be the staging area for backup to tape, our primary backup media.

Putting Together the Pieces

This was a fun project as we could look at a variety of wonderful products to put together a great solution for the test scenario. In the articles to follow, written by MacTech's staff, you'll see a number of different technologies. Some are specific to backups, but many of these you can use in a variety of ways to upgrade your machines. And sometimes, upgrading is the most cost effective way to go, especially when you are talking about a platform as reliable as a PowerMac G4.

The PowerMac G4

In the past several years, Apple has made some simply terrific machines. Sure, the new iMacs and MacBooks are obviously wonderful products, but there are others that are solid performers. One such machine is the PowerMac G4, which many of us have laying around in quantities. These machines have solid power supplies, are expandable, and are quite reliable, but they are not the speediest.

We have found that in addition to our higher-end Xserves, and Mac OS X Server, there are a number of things that we can do with PowerMac G4s running plain old Mac OS X (Panther or Tiger).

In creating a backup system, we knew that we wanted to have several hard drives, multiple Ethernet interfaces, high performance I/O, and more. It was easy to choose the expandable PowerMac G4 for this duty as we didn't need the processing power of G5, and we had several of these PowerMac G4s around.

One of the beautiful things about the PowerMac G4 is that you can have 5 drives in it. Even the exceptional PowerMac G5 doesn't have that capability out of the box. Don't get me wrong, you do have options on a PowerMac G5 to go beyond the two drive positions, but you need to look to third party options such as those from WiebeTech and others for drive module expansions. These are specifically designed to give enough cooling even though Apple didn't design these machines to do this. So, make sure that you are relying on a reputable vendor before putting more than two drives in your PowerMac G5.

What Needed To Be Added

Retrospect

The first choice you have to make on the backup system, possibly even before the hardware you are going to run on, is



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the software. In our case, we wanted something easy-to-use, and even familiar, but that could handle a decent size network. On the Mac, the obvious choice was Retrospect by EMC Insignia.

Retrospect is a great product for the right size market. If you have thousands of clients, should you use it to back up each of them to a server? Nope. You'll want to look at one of the more "Enterprise" level backup systems, or use a Windows or Linux box as a backup server.

One of the limitations of Retrospect is that it can only perform one backup at a time. For a smaller environment (e.g., the SMB space), this works fine. But if you have high end needs, that's beyond the scope of this article, and you should look at other applications like Netvault by BakBone, bru by Tolis Group, or Time Navigator by Atempo. These types of products have the ability to do multiple backups simultaneously to disk (obviously, all products can only backup to one tape at one time). Take note: while these are great solutions, they are industrial, and some of them can cost a great deal of money, and are likely going to take more effort to set up and manage compared to Retrospect.

To be fair, Retrospect is not designed to backup live files. With that in mind, whether it's our Now Up-to-Date server, our FileMaker Server, or the Xserve, we make sure that the live databases are set up to save off copies of the databases periodically to their local drive, and then when Retrospect comes through, it backs up those snapshots.

If you *do* want to backup live files, you really need to look at a different type of software (see above) for a more Enterprise level approach.

SQL Backups: Navicat

As you'll see in the article on Navicat, there are a variety of ways to backup MySQL databases, whether at the command line, using open source options, or a commercial product. In the accompanying article, we give you not only the command line information, but took at a look at the commercial application Navicat, which has some really nice backup and restore functions that you can schedule.

Sonnet SATA/IDE Interfaces

We want to use some existing drives, and experiment with both larger ATA/IDE drives (e.g., larger than 128GB) as well as the newer SATA drives. There are a variety of ways to do this, and we chose the Sonnet products to do this. That allowed us to add both RAID and SATA drives to our PowerMac G4. And, when Retrospect is backing up these drives to the tape drive, they *scream*.

Sonnet Gigabit Ethernet

Since much of the LAN at the main location is gigabit, we wanted to add gigabit Ethernet to the PowerMac G4. And, we didn't want the PowerMac to share that interface for uploads that were being done from the satellite office nor the telecommuter. By adding the Sonnet gigabit Ethernet card, we were able to

dedicate that interface to the LAN, and the built-in Ethernet to the Internet backups that were happening. Since everything happens at the same time at night, this optimized the use of the machine.

SDLT 600

We needed a tape drive for this setup. Today, the two formats that have the most support are DLT and LTO. Both are wonderful, and you can read more on these in the SDLT review that we have. In the end, we chose the SDLT 600 which holds 300-600GB per ~\$100 tape, and in real life usage regularly gets at least 450GB per tape.

ATTO SCSI-3 Interface

The PowerMac G4 does not have an external SCSI interface. You add that with a PCI card. With that in mind, there's only one company that comes to mind: ATTO. ATTO's SCSI-3 interface cards are excellent. And, if you choose the FibreChannel approach, they have options for you there as well.

Media

You can't backup without media, so we chose the Maxell solutions for both SDLT II tapes as well as cleaning tapes to maintain the Quantum SDLT drive.

Daystar Acceleration

At first, we weren't going to accelerate the PowerMac G4, and to be fair, it did run ok without any acceleration. But we wanted to see what the difference was, so we added in a 1.8GHz accelerator from Daystar, and *wow*, what a difference. Well worth the \$330 for this interface card. *Everything* runs so much faster and better than without the accelerator.

Conclusion

By using a variety of solutions, and basing it on a PowerMac G4, we were able to focus as much of the resources as possible on the backup media/drive. To us, this allowed us to get the test scenario onto a backup system that was reliable, modern, and would need as few tapes as possible to hold the data being backed up yet. And, this wasn't your typical "test bench" scenario. While we did design it for a diverse test, we grouped these sets of machines together for a real world test that we did over multiple months and worked out all the kinks. It's as real world as it gets!

Of all the things that you can do on the Mac, I think you'll find that backups are one of the most "diverse" set of choices. There are so many different ways to go. You just have to think it through and prioritize. Once you have a set of ordered priorities, you'll find that decisions start falling into place easily.

Hopefully, this article will help you think through your own examples. But again, even if you don't have backups on your mind, check out the accompanying product solutions, as they will apply to much more than just backups.

As always, let us know what you think!



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ATTO Technology, Inc.

ATTO ExpressPCI UL4S and ExpressPCI UL4D SCSI Adapters

By MacTech Staff

SCSI on Mac OS X

For those of you who have been around to remember SCSI on early Mac OS X, you'll likely recall that SCSI on Mac OS X 10.0 and 10.1, and even to some extent 10.2, was a nightmare: troublesome, error prone, and unreliable. Ultimately, Apple re-wrote the SCSI implementation, and SCSI on Panther and beyond has worked as it should. It would be a mistake to judge SCSI today by those early experiences.

Today's SCSI Experience

When it comes to SCSI on the Mac, the first name that comes to mind is ATTO. ATTO has a variety of technologies, SCSI and others, and a variety of form factors. In our case, we looked at the single connector ExpressPCI UL4S, and the dual connector ExpressPCI UL4D SCSI adapters.

Simply put, these products provided a very pleasurable experience — we installed the cards, and they worked. No drivers. No hassles. It just worked, and it worked well.

To be fair, many people may prefer FibreChannel. It all comes down to what you want to connect to, what is available to you, and what you want the future path to be. If you do choose FibreChannel, you should also take a look at what ATTO has to offer as they are strong there as well.

The Details of SCSI

ATTO ExpressPCI UL4S and ExpressPCI UL4D SCSI adapters are part of the Ultra320 SCSI host adapter series for data intensive enterprise servers and high-end workstations running applications such as high-end video editing, database engines, messaging, and web servers. UL4S and UL4D support up to 30 SCSI bus IDs and Low Voltage Differential (LVD) for cabling up to 12.5 meters per bus. Both products are compatible with single-ended SCSI devices, providing cable distances up to 3 meters. UL4S is a single channel Ultra320SCSI, PCI-X host adapter with data transfer rate of 320 MB/sec,

whereas UL4D is a dual channel Ultra320SCSI, PCI-X host adapter with data transfer rate of up to 640 MB/sec. UL4S and UL4D are compatible with Mac OS X, Windows Server 2003, Windows XP, Windows 2000, and Linux. Dynamic bus rescan is available for Mac OS X only.

While 3 meters of cable is recommended for most applications, when we did our install, the drive was in the rack, and the PowerMac wasn't. We reached out to see what cables were available in longer lengths. We found the folks at 9 To 5 Computer Supply <www.9to5computer.com> had a 10m (yes, 30 feet) cable, and they sent it over for us to take a look at. 9to5 also has a range of other "toys", new and refurbished, with a focus on mass storage solutions.

We plugged the long cable in, and the throughput was spectacular between the ATTO card and the Quantum SDLT II. Be careful when you order cables as there's a variety of connectors for the SCSI 3. In our case, we needed a VHDCI male to HD68.

UL4D is equipped with two external VHDCI, and *two* internal high-density 68-pin connectors. It is 6.521 inches in length and 4.450 inches in height. UL4S features one external high-density 68-pin connector, and one internal high-density 68-pin connector. It is 6.521 inches in length and 4.2 inches in height. UL4D is Mac G5 compatible, and it is available as a standalone or part of an ExpressRAID Kit that includes ExpressRAID Software.



ExpressPCI UL4D



ExpressPCI UL4S

adapters is 0.75 typical/2.0 max. Amps @ + 5.0 VDC, and 0.05 Amps @ + 12.0 VDC with PCI signal compatibility of 3.3 Volts/5 Volts. In terms of reliability of these products, MTBF (mean time between failures) is 150,000 hours, and MTTR (mean time to repair) is less than 15 minutes.

Backward Compatibility and Advanced Streaming

While we were focused on SCSI-3 and newer technologies, there are times you want to be able to use older items. ATTO's proprietary Vpath Technology enables the UL4S, and UL4D to offer users the flexibility of connecting high-speed Ultra320 devices externally, and slower legacy devices internally, or vice versa, without compromising on the performance of the high-speed device. Backward compatibility is supported for Ultra 160,

The UL4S and UL4D both feature a 64-bit/133 MHz PCI-X bus with compatibility to PCI-X 1.0a and PCI 2.2. Accelerated PCI bus management enables PCI Bus Master rate of 1-GB/sec. UL4S and UL4D can operate in temperature range of 0-45 degrees C, humidity 10-90% non-condensing, and airflow 100 LFM (min).

Power rating of both SCSI

Ultra2, Ultra/WIDE, Fast/WIDE and Narrow SCSI devices. The UL4S and UL4D are ASPI (Windows) compatible, RAID ready, PC 99 compliant, plug and play compatible, feature Flash ROM for easy field upgrades, and supports automatic and upper-byte termination for narrow devices.

The Advance Data Streaming (ADS) feature provides controlled acceleration of data transfers utilizing optimized SCSI-3 algorithms, embedded RISC I/O processors for low overhead, and optimized gather/scatter of lists. ADS, facilitates bus mastering eliminating CPU processing time as bottleneck. Tagged command queuing in ADS allows efficient processing of threads, and disconnect/reconnect reduces wait time between transfers.

The UL4S and UL4D also support Ultra320 specific features such as packetized SCSI, read/write data streaming, training patterns, pre-compensation, double transition clocking, Quick Arbitration Select (QAS), Cyclical Redundancy Checking (CRC), Domain Validation (DV), Asynchronous Information Protection (AIP), free-running clock, and flow control. They also support multiple block sizes, and are bootable from attached disks.

UL4S and UL4D come with ATTO ExpressPro-Tools and ATTO Configuration Tool formatting, and utility software. UL4S and UL4D are priced at \$349 and \$499 respectively. Both products are RoHS compliant (2002/95/EC).

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Daystar's G-Celerator G4 CPU upgrade

By MacTech Staff

One downfall to using a PowerMac G4, rather than a newer machine, is the processing power. With an application like Retrospect, that has to do gargantuan amounts of processing for its matching of files and sets, a CPU upgrade is a great way to go.

In our scenario, the PowerMac G4 was a 450MHz AGP machine, so any upgrade was going to be helpful. We chose the mid-range single 1.8GHz G4 upgrade that Daystar sells as it was an economical solution (\$330).

This product made everything in Retrospect run better and faster. It was especially helpful when Retrospect was trying to match sets, and go through the catalogs that it had — normally a daunting task on the G4 450MHz machine. Even opening the log window was much faster.

The end result is that the entire machine ran *far* better than using the built-in 450MHz processor, and we strongly encourage you to look at what you can do with your older machines with this type of solution.

Of course, the brand that has been around seemingly forever in the Mac market is DayStar, so we took a look at the solutions they stand behind.

The G-Celerator

Daystar's G-Celerator G4 MHz CPU upgrade card 1.8 GHz is designed for all PowerMac G4 systems. The higher end upgrades for some of the models can go up to 3600 MHz. The G-Celerator Dual G4 MHz CPU upgrade card is powered by



two Freescale 1.8 GHz PowerPC 7447a (G4) processors (1.42 GHz overclocked to 1.8 GHz) with an AltiVec "Velocity Engine" vector

processing unit, and a 512k on-chip level 2 cache operating at the same speed as the processors. The bus speed of G-Celerator Dual G4 MHz CPU upgrade card is 100 MHz. This upgrade card is designed to support adjusting of bus and backside cache ratios.

Daystar's solutions have great compatibility all the way from Mac OS 9.2.2 through Mac OS X 10.4.5. Daystar has options for a wide variety of the PowerMac G4 and other machines including: AGP (Sawtooth), G4 Server, Gigabit Ethernet, Digital Audio, QuickSilver, and QuickSilver 2002. The G-Celerator upgrade does not support sleep mode on the Power Macintosh, but as a server we didn't care. Sleep mode needs to be disabled for using G-Celerator Dual G4 MHz CPU upgrade card and it cannot boot from Mac OS X disks before 10.3.5. Again, not a problem for our installation.

G-Celerator upgrade cards feature multi-level power settings and "super-cooling" technology. Installation of this upgrade card does take a bit to do, and requires updating firmware and replacing old CPU and heat sink with G-Celerator Dual G4 MHz CPU upgrade card with built on fans and heat sink. It took us about 30 minutes everything said and done.

One interesting thing to note is power consumption. Regardless of the answer, we wanted to upgrade the CPU on this, but we were curious as to how much more electricity this machine would consume compared to a base 450MHz G4 machine. In the end, the upgraded machine used close to 50% more electricity. In real terms, this is about \$5/month (we're about \$0.25 per kWh in Southern California) ... well worth the benefits from this machine working faster.

This is an enjoyable upgrade. Well worth \$330 if you need the processing power as we did in the backup solution.

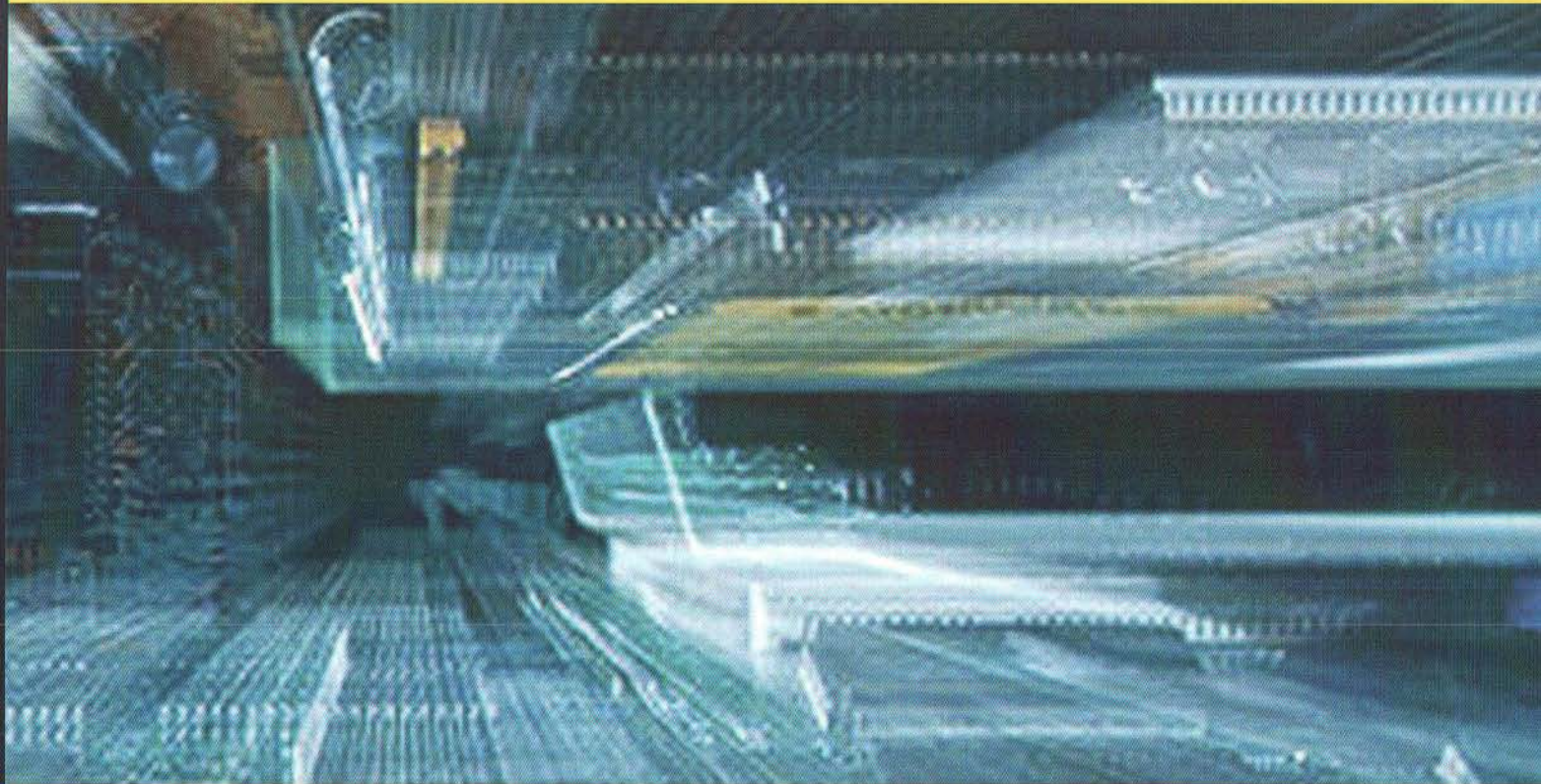
G-Celerator G4 MHz CPU upgrade cards come with 3 year manufacturer limited warranty and Daystar has solutions starting at \$299 for the 1GHz+ solutions.

<http://www.daystar-tech.com/>

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Maxell's Super DLTtape II

By MacTech Staff

Oh Yeah, Media

We've talked a lot about backup, however, your backup is only useful if you can read the data back and restore. So, after you've invested all this effort, and money, in your backup system, it makes no sense to skimp on the media.

Since we've had great experience with Maxell media, we chose it again here. Maxell's Super DLTtape II cartridge has a capacity of 300 GB and 600 GB in native and compressed mode with transfer rates of 36 and 72 MB/sec. In our use, we regularly saw 450GB per tape, and even at a cost of around \$100 per tape, this was amazing compared to what we've seen with other media in the past.

For the tape geek in you, Super DLTtape II features NeoSMART (Neo Super Maximum capacity Advanced Reliability Tape technology platform) for higher capacity, and proprietary ultra-fine ceramic coated metal particle tape for guarding against humidity, heat, oxidation, and abrasion.



Super DLTtape II is equipped with a buckling system that supports operation in heavy-duty cycle scenarios, and ensures a secure link with drive leader. The tape lock mechanism maintains proper tape tension preventing tape movement and slack. Advanced polishing technology produces a smooth magnetic layer for less head abrasion and better writing/reading, whereas Optical Servo enables tracks to be written on the

back, freeing up 100 percent of tape for increased data storage capacity.

What does this all mean? It means that Maxell has paid attention to make sure the tape doesn't get caught up in the drive mechanism, and just works.

The tape in Super DLTtape II is 1/2 inch wide and 2,066 feet in length. It has a durability rating of 1,000,000 passes, coercivity of 2,600 Oe, and an archival storage lifespan of more than 30 years. Operating temperature range is 50 to 104 degrees F, and operating humidity range is 20 to 80 percent RH. Storage temperature range is 60 to 90 degrees F. Archival temperature range is 64 to 82 degrees F, and archival humidity range is 40 to 60 percent RH. High coercivity and better remanance result in lower noise level and high density recording for accurate reading. The cartridge measures 4.16 x 4.15 x 1 inches.

The tape is also anti-static, dust resistant, and comes in blue for easy recognition. The package is factory-sealed and a custom barcode labeling service is also available. Even the new labeling system is easy to use, and easily replaced if you change the purpose of the tape.

Maxell also makes great cleaning tapes. Each of these can be used up to 25 times, and it takes care of counting for you so that you don't do damage to your drive by cleaning with an already used cleaning tape. With SDLT, you don't clean proactively, only when the drive is asked, so we've not had as much experience with these cleaning products as we have with the tapes, but they are pretty simple: you put them in, they clean, you are done.

Super DLTtape II is sold through a number of online resellers for as low as \$95. Cleaning tapes are about the same, or slightly less.

For more information visit:
<http://www.maxell-data.com>



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Navicat: More Than Just Backing up MySQL

By MacTech Staff

MySQL Management Tools

There are a number of ways to manage and even backup your MySQL databases. Some people prefer the command line. Others decide that they like a web interface like phpMyAdmin. Finally, you may want to use a standalone application that's a GUI like CocoaMySQL, MySQL Administrator or Navicat.

Because of the issues of backing up a live MySQL database, and even more the case with Retrospect with MySQL databases (see the article on Retrospect in this issue for more information), we needed to find another way to backup our MySQL databases.

If you decide to do this at the command line, you can use 'mysqldump' in a cron job:

```
mysqldump -A -a --add-drop-table -u username -password  
"thepassword" > backup.sql
```

You can restore it with:

```
mysql -u username -p < backup.sql
```

The benefit, of course, is that this doesn't require any additional product, it's reliable and it's secure. You can drop it into a script, if you'd like, but if you do, make sure it's owned by root and can only be accessed by root (0700). And, if you do this, you can add in a "logger" statement so that you can monitor things, or ask cron to mail you the output by default. Then again, you may want a GUI, and want to be able to touch the results a bit more easily than what cron does for you.

Why Navicat?

We chose Navicat specifically because of its easy to use scheduling features to backup SQL databases, restore them easily, and even replicate data between databases for nightly updates.

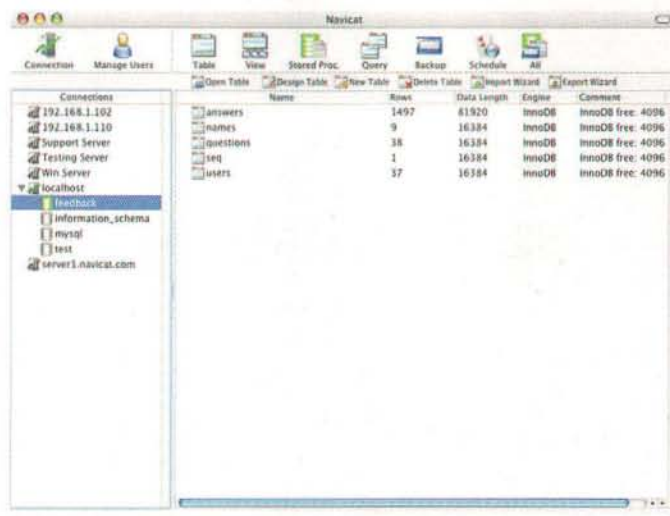
While we started to use Navicat specifically for backups of the MySQL databases, we found a variety of other uses. Specifically, if you aren't fluent with MySQL queries, Navicat helps by allowing you to define a query through the GUI and then shows you what the resulting query would look like.

About Navicat

Navicat is a MySQL database administration and development tool that allows professional developers as

well as new users to create, organize, access, and share information in a secure and convenient way. Navicat supports multiple MySQL server connections which can be connected locally or remotely (remote MySQL server can be running on Mac OS X, Linux, UNIX, or Windows platform). Navicat requires Mac OS X 10.1 or later.

Some of the important features of Navicat for Mac OS X include SSH Tunnel, data and structure synchronization, SQL console, views, stored procedure, trigger creation, support for all MySQL server versions above 3.21, creation and deletion of databases, tables, indexes, and users, stored procedures, foreign keys, Unicode and character set support, import / export data in up to 4 most popular formats (CSV, TXT, DBF, and XML), creation / execution of SQL queries, printing table structure, creation of schedule for backup, backup / restore of database, saved queries, support for transferring databases from one MySQL server to another MySQL server, and managing user privileges.



Navicat: Main Interface

Navicat's main interface comprises Server Navigator and Database Window. Server Navigator displays a list of server connections assigned in Navicat. These connections can be set by Navicat to open automatically on start up. Navicat provides 10 views: Connection, Table, View, Stored Proc., Query, Backup, Schedule, Data Transfer, Data Sync, and Structure Sync. Database Window shows the content of the chosen view.

Navicat's SSH tunneling feature can be used to encrypt communications between Navicat and a remote MySQL server. Many MySQL hosting providers block access to the MySQL server from outside hosting company's network, and only grant access to users connecting locally. SSH tunneling allows connecting to a MySQL server from behind a firewall when the MySQL server port is blocked. Navicat's port forwarding function can be used for connecting provided SSH access is available from the hosting company. Navicat communicates with the remote MySQL server in plain text (with the exception of the user password). Navicat's port forwarding function provides security of communications with the MySQL server and it protects MySQL sessions from various attacks.

Typical operations that can be carried out on databases by using Navicat are creating database, opening database, renaming database, deleting database, copying database, moving database, and maintaining a database. Maintenance options for a database include optimize, analyze, check, and repair.

Navicat allows the following operations to be performed with tables: creating a table (from scratch/from an existing one in the database), open a table, design a table, empty a table, duplicate a table, and change table type. In addition to these functions, Navicat also offers functions to maintain a table. These functions include optimize table, analyze table, check table, and repair table. Navicat also features a Filter Wizard that can be utilized to filter records in Navicat's Table Window. Filters can be saved for fast retrieval and they can also be saved to a profile for retrieval when table is opened again.

The options available with Navicat to work with queries are creation of query, opening or running a query, deleting a query, saving a query, and loading SQL file. All the query actions can be stored in a log file for tracking. Navicat also features its "Visual Query Builder" that can be used to create join queries with options to specify selection, grouping, sorting, and projection criterion. SQL Console can be used to run SQL queries. It simulates the command line environment of MySQL.

Stored procedures and functions were introduced in MySQL in Version 5.0. Navicat supports following operations related to stored procedures and functions: create stored procedure/function, design stored procedure/function, and delete stored procedure/function. The feature of views was also added to MySQL Version 5.0. Navicat allows creation, design, and deletion of views.

Navicat's Table Window enables editing, adding, deleting, and sorting data in a table. It also features a blob edit control that facilitates editing of binary data. Navicat can be used to manage user and host privileges. Privilege management operations provided by Navicat include user privilege operations such as creating new user, deleting existing user, and setting privileges of a user, and host privilege operations such as creating new host, removing existing host, and setting privileges of a host.

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Navicat's Backup Tools

Navicat's backup feature allows backup of all tables and records of a MySQL database. Backup can be restored by using Restore Backup function. Backup operations allowed by Navicat are creation of new backup, restoration of a backup, deletion of a backup, and extraction of SQL from a database. Navicat's data transfer feature allows transfer of tables/records from one MySQL database to another MySQL database or a plain text file. The target database can be on the same server as the source database or on another MySQL server. Navicat allows saving of a profile for easy retrieval and running of data transfer between databases. Data transfer operations offered by Navicat are creating a new data transfer profile, deleting a data transfer profile, and setting up general and advanced settings.

Navicat can be used to create batch jobs for automating functions such as backup, restore backup, data transfer, import and export. Batch job can be used to execute a series of actions one by one by just executing the batch job. Batch job can also be scheduled to execute at a specified time.

What is MySQL Doing?

One of the cool features of Navicat is that you can see what your MySQL database is doing. There's obviously a variety of other ways you can do that. In the case of Navicat, the GUI has a server monitor that can show MySQL Server Process List, MySQL Server Variables, and MySQL Server

Status properties from the selection of MySQL servers. The data synchronization functionality of Navicat transfers data from one database to another with detailed analytical process. The user is authorized to rollback the transferring process, in addition to inserting, deleting and updating records to the destination. The synchronization profile can also be saved for setting a schedule. Navicat also provides structure synchronization to compare and modify the structure of tables with a detailed analytical process.

Conclusion

One of the open source alternatives or the command line may work great for you. In the end, it all depends on what your needs or desires are. If you are looking for a commercial application that can help you reliably with backups and data transfers, we found Navicat did the job well.

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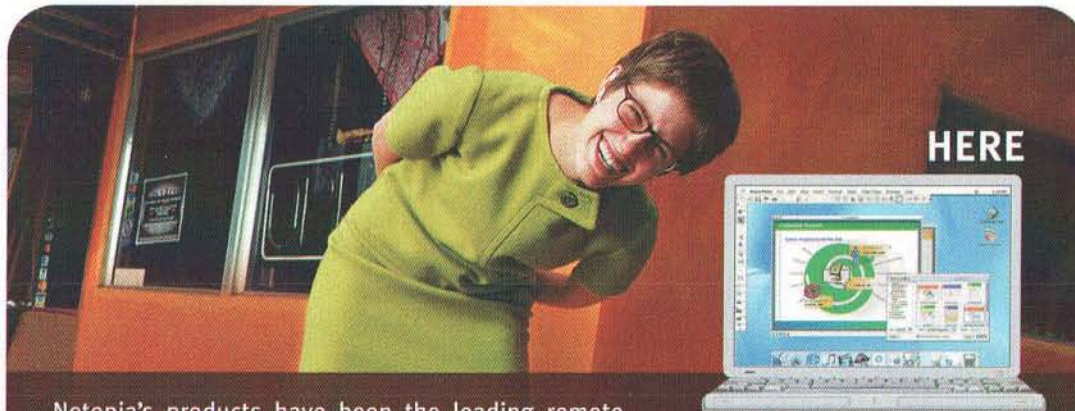
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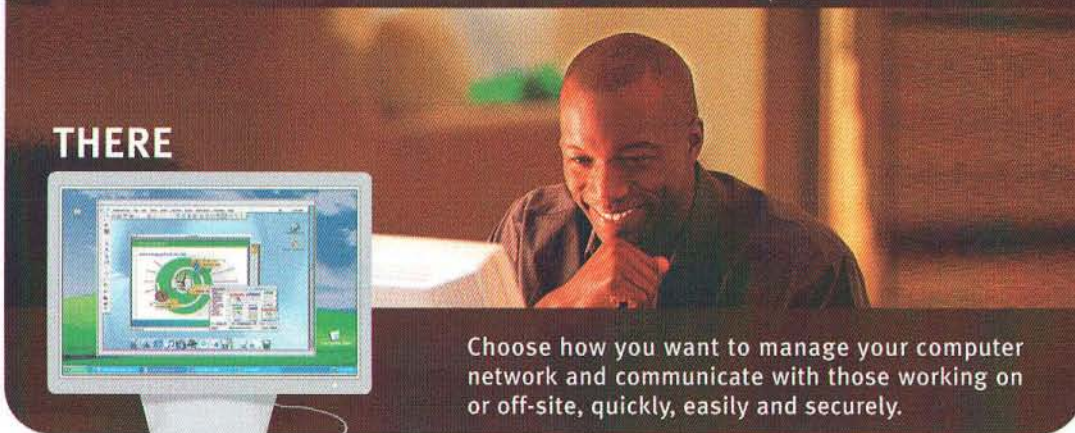
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Quantum's SDLT 600 Tape Drive System

By MacTech Staff

Quantum is in an interesting position in the market, in that they are leaders with both their DLT and LTO technologies. Both of these technologies are great, and have multiple sources for media. The first priority for DLT is capacity, and the first priority for LTO is speed. That said, LTO's capacity is terrific, and DLT's speed is no slouch either. To be fair, DLT was invented by Quantum. LTO, on the other hand, was invented by IBM. Quantum acquired Certance a while back which gave them a firm foothold in the LTO market, allowing Quantum to give their customers a wider array of choices.

For MacTech, capacity was the highest priority, so we went the DLT direction. There are several different levels of DLT from the most economical to the highest capacity. The latest in the DLT family is the DLT-S4 which holds a whopping 1.6 terabytes per cartridge (compressed) which is twice the capacity of the LTO-3 standard, and nearly three times the SDLT 600 that we selected for this review.

Whether you choose DLT or LTO, there are a variety of auto loader and library solutions for you to choose from. It's all a matter of budget, and how much you need to back up. Both have road maps for the future. DLT is on path to ultimately get to 14 terabytes per cartridge.

The bottom line is that no matter what you decide, DLT or LTO, you are bound to be pleased. Both are great technologies, with great brands behind them, lots of tape vendors, and are speedy with high capacity.

The SDLT 600

SDLT 600 tape drive systems are at the upper end of Quantum's line of digital linear tape drives that include the SDLT 220, SDLT 320, and of course, the new DLT-S4. The SDLT 600 tape drive system comprises both the tape drive and the data cartridge. The tape system is available in four versions, an internal unit for server installation, a tabletop unit, a rack mount, and a library model for installing in tape automation systems. The tape drive provides 300 GB of storage capacity with a transfer speed of 36 MB/sec in native mode, and 600 GB of storage capacity with a transfer speed of 72 MB/sec in compressed mode.

MacTech has regularly been able to get 450 GB out of tapes in real world usage.

SDLT 600 contains on-board hardware to compress and decompress data using a DLZ algorithm. The default setting for data compression is on. This system utilizes DLTsage, a data management solution that allows users to manage, predict and prevent problems before they occur. It also comes with DLTice, which provides WORM (Write Once, Read Many) archival functionality, although we did not experiment with this.



Quantum SDLT 600, Dual unit Rack Mount Version



Quantum SDLT 600 Table Top (External)

Nitty Gritty Details

For those that care about the nitty gritty details, SDLT 600 has 40 logical and 640 physical tracks with a track density of 1502 tracks per inch (tpi). Linear bit density is 233 Kbits per inch (Kbpi) with read/write tape speed of 108 inches per second (ips), rewind tape Speed of 160 ips, and linear search tape speed of 160 ips. The average rewind time, maximum rewind time, average access time (from beginning of tape), and maximum access time (from beginning of tape) are 77, 156 seconds, 79, and 190 seconds respectively. The typical load from the beginning of tape time and unload to beginning of tape time are 18 and 19 seconds respectively, while load to beginning of tape for unformatted tape takes 63 seconds. Nominal tape tension is 3.0 ± 0.5 oz for stationary drive, and 3.5 ± 0.5 oz at operating speed.

SDLT 600 is a streaming tape drive that uses half-inch wide Super Digital Linear Tape (MR-S2MQN-01) media and offers backward read compatibility with the SDLT 220 and SDLT 320 tape drive formats, Super DLTtape I data cartridge type, and the DLT VS160 tape drive format with DLTtape VS1 data cartridge type. It does *not*, however, have the ability to use the older DLT tapes that look like they would fit, but don't. Definitely do not try this: you'll damage the drive.

This tape drive utilizes the SDLT Cleaning (MR-SACCL-01) cartridge. But, don't go out and buy a ton of

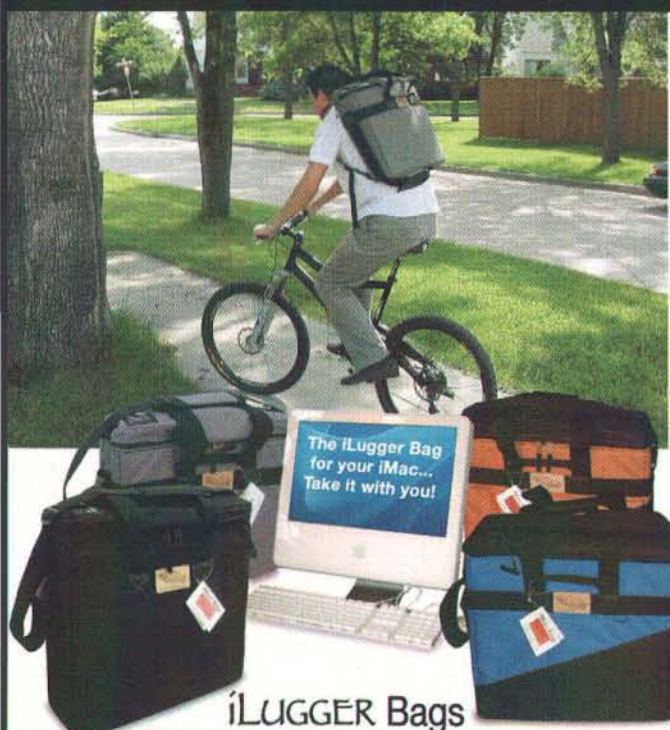
these ... they work for 25 cleanings, and you should not clean proactively, only when the drive asks for it (through the indicator light or software). After months of using this drive for every day backups, we've yet to clean it.

This product is powered by Quantum's Laser Guided Magnetic Recording (LGMR) technology that provides a combination of the optical and magnetic technologies, resulting in higher capacities by substantially increasing the number of recording tracks on the data-bearing surface of the media. It is equipped with Pivoting Optical Servo (POS), a Quantum-invented, optically-encoded servo system, that combines high-density magnetic read/write data recording with laser servo guiding. The system also features Magneto Resistive Cluster (MRC) heads, advanced Partial Response Maximum Likelihood technology, Advanced Metal Powder (AMP) media, and positive engagement tape leader buckling mechanism.

SDLT 600 also comes with the TapeAlert feature that enables constant monitoring of the device's hardware and media for errors and potential difficulties by an internal SDLT firmware. It flags any problems identified on the SCSI log page, where 64 bytes are reserved for TapeAlert.

This tape drive is available with either Ultra 160 SCSI or Fibre Channel interfaces. The Ultra 160 SCSI interface provides a low-voltage differential (LVD) mode running up to 160 MB/second and a single-ended (SE) mode running up to 40 MB/sec. Fibre Channel interface runs at speeds up to either 1 Gb/sec or 2 Gb/sec, depending on

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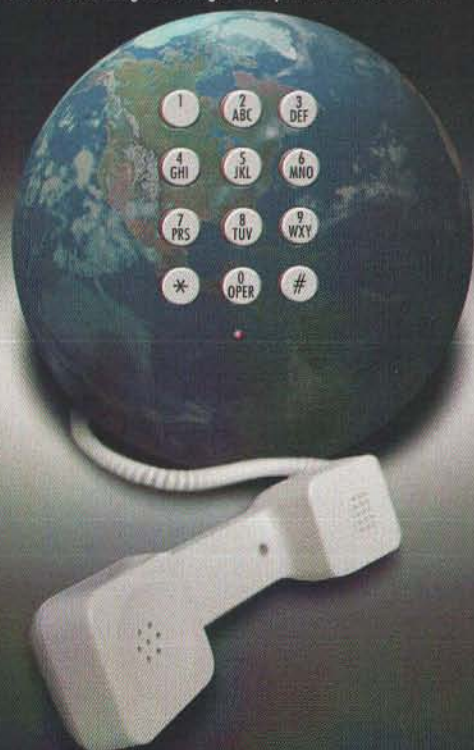
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the configuration chosen during installation. Fibre Channel can support up to 126 devices in a loop configuration. Long wave transceivers (with fiber optic cable) support distances up to 10 Kilometers, and the shortwave transceivers (with fiber optic cable) support distances up to 500 meters.

We tested the Ultra 160 SCSI version in our installation.

The projected MTBF (mean time between failures) for SDLT 600 is 250,000 hours. Head life is a minimum of 30,000 tape motion hours, and an average of 50,000 media motion hours. In terms of media durability, the number of media passes and full media uses to expect from a Super DLTape II data cartridge are 1,000,000 and 250 respectively. In terms of data cartridge life expectancy, the number of load/unload cycles and media insertions to expect before the data cartridges need to be replaced are 5,000 and 20,000 respectively. The positive engagement tape leader buckling mechanism engages the tape leaders upon data cartridge load, and disengages them upon data cartridge unload. This allows buckle arm components including take-up leader, supply leader, and the media to function for at least 250,000 cycles on an SDLT 600 tape drive without failure, breakage, or binding.

Conclusion

This product was simply a pleasure to review, and to have in our network. It's must be part Macintosh, as from day one, we plugged it in, and it just worked. Two thumbs up!

We found an assortment of online resellers for the two tape drives with prices as low as:

Quantum SDLT 600 Internal: \$ 2,899

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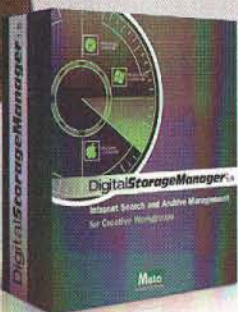
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EMC-Insignia Retrospect 6.1 for Macintosh

By MacTech Staff

If you've been around the Mac market for a while, you know of Retrospect. Originally created by Dantz (which was acquired by EMC a while back), today Retrospect is under the brand EMC-Insignia, but it's still the same familiar Retrospect you are used to.

Retrospect 6.1 for Macintosh is designed to automate cost-effective protection for small and medium businesses (SMBs). While lagging behind Retrospect 7 for Windows, Retrospect 6.1 for Macintosh provides a solid backup solution for file servers, desktops, and notebook computers.



Retrospect 6.1 for Macintosh is available in Server, Workgroup, Desktop, and Express editions. The Server and Workgroup editions of Retrospect cater to business environments with a client/server approach. Retrospect Server edition comes with licenses to protect 100 networked

servers, desktops, and notebooks. Retrospect Workgroup edition provides licenses to protect 1 networked server and 20 desktops and notebooks. Licenses for additional networked computers can be purchased separately. Retrospect Desktop edition is designed to provide capabilities of Workgroup and Server editions to home users. Retrospect Desktop edition provides licenses for 2 networked computers. Retrospect Express edition is available exclusively with backup devices.

Retrospect 6.1 for Macintosh Server and Workgroup editions can be run on any server running Mac OS X Server 10.1.5 through Mac OS X Server v10.4 Tiger. Retrospect Server, Workgroup, and Desktop editions can be run on any desktop/notebook running Mac OS 9 or Mac OS X 10.1.5 through Mac OS X v10.4 Tiger. Retrospect can be used to protect networked desktop and notebook clients running Mac OS 7.1 or later, Mac OS X 10.1.5

through Mac OS X v10.4 Tiger, Windows XP, Windows 2000 Professional, Windows NT 4.0 Workstation, Windows 95/98/Me, and Red Hat Linux (versions 6.2, 7.1, 7.2, 7.3, 8, and 9). Retrospect provides protection to networked servers running Mac OS X Server 10.1.5 through Mac OS X Server v10.4 Tiger. Retrospect 6.1 for Macintosh Server, Workgroup, and Desktop editions are compatible with backup devices including hard drives, removable drives, CDs/DVDs, FTP servers, and tape drives. Retrospect Server and Workgroup editions also support tape autoloaders and libraries.

The minimum hardware requirements to run Retrospect are a Macintosh G3 or better and Mac OS X version 10.1.5 or later. Retrospect Desktop edition requires minimum of 128 MB RAM (256 MB recommended). Retrospect Workgroup and Server editions require minimum of 256 MB RAM (512 MB recommended). Retrospect also requires a hard drive with a minimum of 200 MB free space. But, let's be real. You want at least a G4 running this software, with a reasonable amount of RAM. And, while Retrospect does run on earlier versions of Mac OS X, we strongly recommend that you work with at least 10.3 especially if SCSI is involved. In the end, you need to assess your needs and adjust appropriately.

In case you are used to AppleTalk support, note that the most recent versions of Retrospect work on TCP/IP, not AppleTalk. Not a big deal for most, but important to some with older systems. You need to have TCP/IP on each machine, even those on Mac OS 9.

The "Backup Set"

A backup set is the basic building block of Retrospect, which comprises one or more disks, tapes, or discs, or a file or FTP site. The various types of backup sets that can be used with Retrospect are tape backup sets, CD/DVD backup sets, removable disk backup sets (Zip, Jaz, SuperDisk, DVD-RAM, MO, as well as USB and FireWire hard disks), and Internet backup sets. For a backup, the source is generally a hard drive or a folder on a hard drive (Known as volumes and subvolumes respectively).

In our test scenario, we backup to multiple media: disk, over the Internet, and to the SDLT II SCSI-3 drive.

This variety of scenarios, along with ease of use, is the type of thing that Retrospect excels at.

Retrospect uses an archival method of backup that ensures backed up files are not deleted or written over until requested by user. Retrospect touts their patented IncrementalPLUS technology to perform backups, which copies only files that are new or have changed since the previous backup to the same backup set. There is no need to specify a "full" or "incremental" backup. Retrospect, by default, copies only the files it hasn't already backed up to the destination backup set. Retrospect uses a catalog file (stored on hard disk) to track the different generations of modified files in a backup set. The catalog enables a search of files eliminating the need of searching the backup media itself. (This is one of the places that you really want to have processing power and RAM.)

Retrospect's usage of IncrementalPLUS backups may result in several versions of a file scattered among several backup sessions within a backup set. This makes for faster backups, but it is a bit of a pain when you do a restore as you'll have to insert every tape, one at a time. Frankly, it's the right way to do this otherwise backups would take forever and you'd be changing tapes all the time during backups (much worse)!

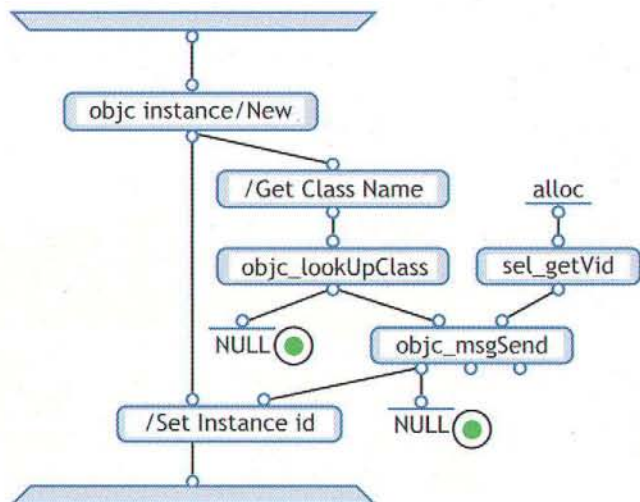
A list of all versions of all the files in the backup set would be overwhelming. To avoid this problem, every time a backup is performed, Retrospect places a

"Snapshot" of the source volume in the backup set. A Snapshot is a list of all files and folders on a volume when it is backed up. For each volume, one Snapshot is stored in the catalog and a copy of the same Snapshot is stored on the backup medium. The old Snapshot is replaced with a new one after each successful backup operation. Old Snapshots on the backup medium are not deleted. Retrospect can use a Snapshot to restore, in case restoration of a backup is required. Snapshot can also be used as a guide to see the volume as it was at a given point in time, and then pick and choose individual files to restore. This is some of the most powerful stuff that Retrospect has to offer, and a reason that Retrospect can be used in so many different ways.

Retrospect Clients can extend the backup and restore capabilities of Retrospect to other computers on a network. Retrospect can back up clients on the network without the need for installing file servers, starting file sharing, or mounting volumes. Retrospect's Backup Server offers scripted backups, which prioritizes the volumes most in need of backup and copy their files to the available backup set containing the least current data. Backup Server technology is suitable for environments in which mobile computers and removable disks irregularly appear on the network. Retrospect client users can even initiate backups of their volumes. A Backup Server script is often used along with regular backup scripts to produce an elaborate backup strategy.

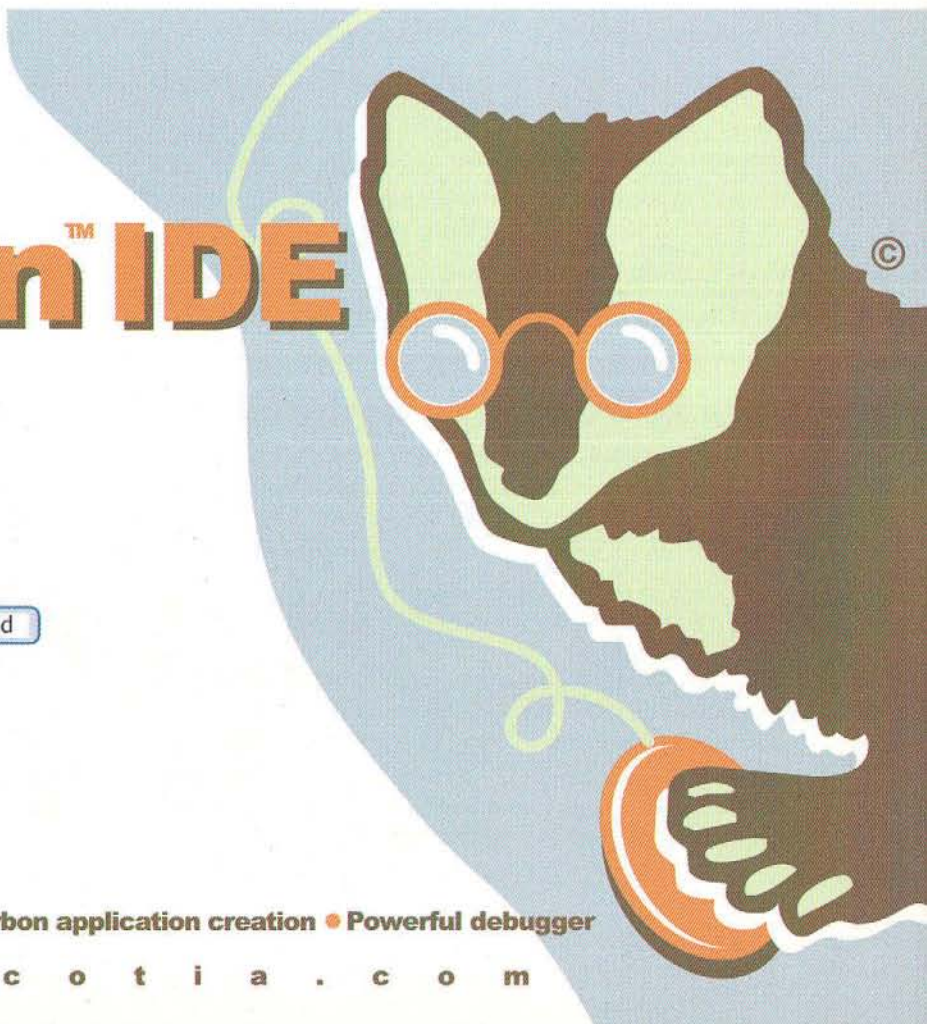
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Retrospect 6.1 for Macintosh provides a number of ways to protect and restore data including two basic categories of operations: immediate operations and automated operations. Immediate operations are initiated manually and executed immediately. They include backup, archive, restore, duplicate, and transfer. Immediate operations can be automated by creating scripts. These scripts automate the repetitive tasks of these operations. Retrospect offers three ways to create scripts: the EasyScript Wizard, scheduling an immediate operation and using the Automate>Scripts command.

Retrospect uses hardware intensively, to transfer large amounts of data between a source volume, such as a hard disk, and a backup device, such as a tape drive. As you might imagine, Retrospect is the “king of drivers”, and is able to communicate with hardware devices using a wide variety of technologies including SCSI, Fibre Channel, ATAPI, FireWire, and USB. Retrospect supports Fibre Channel tape drives and tape libraries using Point-To-Point, Arbitrated Loop, and Switched Fabric topologies.

Backups Over the Internet

One of the things that we wanted to tackle in the test article is backing up telecommuters and satellite offices. There are a variety of ways to do this that we experimented with: mounting volumes over AFP, FTP, backing up a remote client and more. In the end, the way that worked best was to use Retrospect Server to *push* data to Retrospect Client rather than the typical *pull* data from the client. In other words, normally the server is attached to the storage device for the backup. You would pull data from the client to the server, and store it on the tape or hard drive attached to the server. In “push” methodology, you would use the Retrospect Server software to push data via the Retrospect Client installed on the backup server where the backup stored. Seems a bit unusual, but it works great.

Depending on your setup for a remote install, you could simply have your Retrospect Server talk to the client over the Internet, and that will work fairly well. The one issue with this is that your Retrospect Server will not be able to work on anything else until that backup is done. We chose to avoid this as our backups would not be able to finish overnight in the test scenario.

A second approach would be to use FTP or AFP to mount the volume, and then write to it. While this approach can work, it's not particularly resilient to poor Internet connectivity issues, and more importantly, it is painfully slow over moderate net connections like DSL or cable modems. The slowness is really not about the copying time, but the scanning time. It is very slow to scan a remote machine mounted on the local desktop.

The approach that we ended up with was to install Retrospect Client on the backup server, and then use Retrospect Workgroup to copy the data from the remote office *up* to the backup server using the Client on the backup server. Feels a bit backwards at first, but it works great and transparently. In fact, we went one step further and had a workgroup server running Retrospect Workgroup at the satellite office, copying relevant data on each machine in that office to the workgroup server (in other words, do prep work by consolidating all the data that we wanted to backup to one folder). Then, we “upstaged” that data from the prep folder to the main backup server by running Retrospect Workgroup at the satellite office, and using Retrospect Client on the main backup server.

The telecommuter that we had in the test network would do the same thing as the satellite office, but only one would work at a time (given that currently, the Retrospect Client can only talk to one server at a time.) The cool thing is that the second network backup will just sit and wait until the Client is ready. So this works fine.

Doing this allowed us to still make daily backups (and snapshots) to tape on the main backup server, and gave us a very powerful backup solution.

If you do set things up in this way, we strongly encourage you to use Retrospect's “Link Encryption” so that what you send out over the Internet is encrypted. On slower machines, working exclusively within a LAN, this could have a performance impact. But, over the Internet, the bottleneck will be your net connection.

One last thing: we found it useful to have the backups coming in over the Internet to go over the second Ethernet interface so as not to take anything away from the LAN backups. We did this with a separate IP address, and at times, we even did traffic control to move this traffic over our backup connection at the main location (instead of the primary location).

MySQL and Retrospect Don't Like Each Other

One issue that we ran into with Retrospect is live files. In our case, one of our Xserve's is a live web server and runs MySQL. As you might imagine, MacTech's web site gets more than a little bit of traffic, and the MySQL server is hit constantly for a variety of reasons. Whenever Retrospect would back up this machine, it would literally bring the Xserve to its knees and we would have to restart the Xserve to recover.

To get around this, we had to “exclude” MySQL files from the backups, and use something different to back them up (see Navicat article). And, as we mentioned in the overview article, we made sure that any of the database servers (FileMaker, Now Up-to-Date event server, etc...) all used their own method of backing up a

database to the local disk. Retrospect would just back up those snapshots when it backed up that server.

Cross-Platform Backups, Retrospect for Windows

One of the nice things about Retrospect is that it does support a variety of different OSes. While that may not be as extensive as other applications on other platforms, if you are primarily a Mac network with some Windows machines on it, you'll have no problem running Retrospect Server on your Mac.

Be careful about updating your Windows client machines if you are using Retrospect Server on the Mac to back up those machines. The Windows version is ahead of the Mac version as we speak, and you could run into capability issues if the Windows version gets too far ahead of the Mac version.

Rotating Sets, Off-Site Backups

We've always told people "don't backup what you can afford to lose." Of course, we were trying to drive a point home on the importance of backups. But you should really take this a step further: "don't keep an offsite backup for anything you can afford to lose."

The next question is what is the best approach. Some people have one backup set (e.g., a set of tapes)

for each day of the week. In our test case, we found that the tapes held so much data that we could take a different approach and not change tapes often. In that approach, we simply use two sets, and keep one off site at all times. We switch them once a week, so our off-site backup is never more than a week old, and we retire sets every 3 months to keep the tapes maximally fresh, and tape sets small.

You need to find the mix of rotations, and retiring backup sets that works best for you. It will definitely take some experimentation as there's a nearly infinite number of ways to go.

Conclusion

If you are looking for easy to use, easy to set up, and a tried and true solution for small and medium size businesses, or even at home, Retrospect 6.1 is a great way to go, and we recommend it wholeheartedly.

Retrospect Server v6.1: \$799.00
Retrospect Workgroup v6.1: \$499.00
Retrospect Desktop v6.1: \$129.00

Available from: <http://www.emcinsignia.com/>

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Expansion Options from Sonnet

By MacTech Staff

Expandability

One of the beautiful things about a PowerMac G4 is how expandable it is. Even more so than today's PowerMac G5s in some ways. The PowerMac G4 has an ample power supply, plenty of room for drives, and was designed that way in the beginning. With 5 drive slots in addition to the optical drive and floppy, there's a lot of room in there.

The problem is that, depending on the model, earlier PowerMac G4s do not natively support drives other than IDEs that are less than 128GB. Obviously, for a backup system, you'll want to take advantage of the larger drives that are available and economical today, and you have two choices as to how to go about doing this.

In addition, since this is a backup system, you may want to take your PowerMac G4 from 10/100 Ethernet to gigabit. Just throw in a PCI card and you'll have it. You can also make use of multiple Ethernet interfaces simultaneously, another handy setup for a backup system. Also, don't forget about IP over Firewire as another network connectivity option.

Modern ATA and SATA

The first way to increase the storage capacity of a G4 is to go with a more modern version of the ATA standard. With a PCI card you can put into your PowerMac G4, you can handle drives larger than 128GB. You can do this either with individual drives, or as a RAID setup.

The second way is to put Serial ATA (or SATA) drives into your PowerMac. They look very similar to the former ATA drives but both the power and the interface cabling (not to mention the interface itself) is different. SATA drives are what newer Macs (PowerMac G5's, iMacs, and Xserves). SATA has the benefit of being very economical and available in the larger sizes.

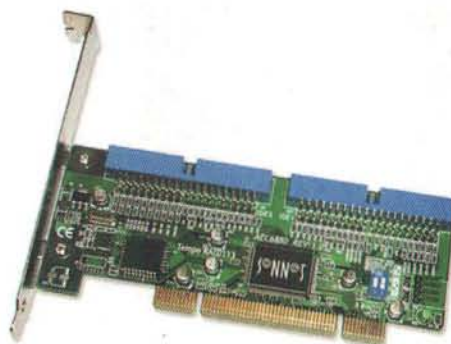
We'll take a look at interface cards for both of these options, but unless you have a specific need, or drives you are trying to support, we advise moving everything to SATA that you can.

Tempo RAID133

Tempo RAID133 is an ATA hardware RAID controller that can be used to connect high-performance ATA hard

drives into Power Mac G3 or G4 to create fast hardware RAID volumes economically. Tempo RAID133 is compatible with Apple Power Macintosh G3 and G4, and it supports Mac OS 8.5 through 9.2.2, and OS X (which is obviously where we're focused). Tempo RAID133 supports Apple Drive Setup Utility (version 1.5 or later) or other third-party software for drive formatting, but also Mac OS X's Disk Utility.

Equipped with hardware RAID level 0 (striping), Tempo RAID133 supports up to two volumes (two ATA/IDE hard drives per volume, four drives total) of internal drives. Tempo RAID133 supports drive types including any ATA/IDE fixed media hard drive such as Ultra ATA/33, Ultra ATA/66, ATA/100, and ATA/133. Tempo RAID133 features onboard 32-bit PCI Bus Master and it supports drive protocols through ATA6. Tempo RAID133 offers data transfer rate of 133 MB/s per channel with Ultra ATA/133 and up to 133 MB/s in burst master cycle.



Tempo RAID133

Tempo RAID133's striping function provides significant performance gains over a single hard drive. The improvement makes Tempo RAID133 suitable for disk-intensive tasks such as multimedia authoring, image editing, and of course, our goal of backups. Tempo RAID133 utilizes onboard Open Firmware, which allows booting from attached drives to shorten start up times and speed Mac OS operation. The onboard firmware automatically recognizes and configures the drive type, in addition to 80-wire cable with Ultra ATA/66, ATA/100, and ATA/133 drives. It is backward compatible with ATA/33, ATA/66, and ATA/100, and is Flash-ROM upgradeable.



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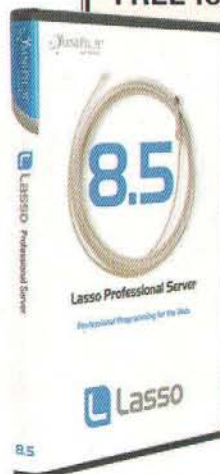
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Advance features of Tempo RAID133 include coexistence with SCSI and onboard IDE devices, support for simultaneous operation of multiple cards, and CRC error checking ensuring data integrity with Ultra ATA/133 drives. Tempo RAID133 comes with 40-pin/80-wire IDE cables (two included; 80-wire cable required for full Ultra ATA/66, ATA/100, and ATA/133 support). The package also contains a quick start guide, power supply "Y" cable, and 8 hard drive mounting screws. Tempo RAID133 is priced at \$149.95 and it is available with 3-year limited warranty.

We found this product to be a great experience. It's not only flexible in allowing you to work with different sizes and kinds of drives, but it's simple to install and works as advertised ... just as you would expect on the Mac.

Tempo Serial ATA and Tempo Serial ATA Cable Kit

Sonnet's Tempo Serial ATA PCI adapter card enables connection of Serial ATA (SATA) and parallel hard drives to older Macintosh computers. Tempo Serial ATA can be used to take advantage of SATA's higher data transfer rates and improved cabling performance. Tempo Serial ATA features 48-bit LBA support for drives larger than 128GB and support for mirroring and striping features of OS X. Tempo Serial ATA requires Mac OS 8.0 through 9.x, and Mac OS X version 10.2 or later. It supports Mac OS bootability from attached drives. Tempo Serial ATA runs on a 32 bit, 33/66MHz PCI bus and it is compatible with 32-bit PCI bus version 2.2 and hard drive or peripheral power connectors. The card comes with 2 internal Serial ATA interface

connectors that each support up to 2 hard drives. Each port also offers data transfer rates of up to 150 Mbytes/second or burst data transfer rate of 1.5 Gbits/second. Drives modes supported by the product include Serial ATA, Ultra DMA modes 6/5/4/3/2/1/0, and PIO modes 4/3/2/1/0.



Tempo Serial ATA PCI Card

Advanced data features include compliance with the Serial ATA 1.0a specification, bus mastering that off-loads data I/O handling from the CPU, 32-bit CRC error checking for all bits transmitted (command, data and status), offering enhanced data protection for high-speed Serial ATA drives. It also sports dual independent data channels allowing separate device timings, automatic identification and configuration of drive types, and automatic detection and support for devices utilizing many transfer modes.

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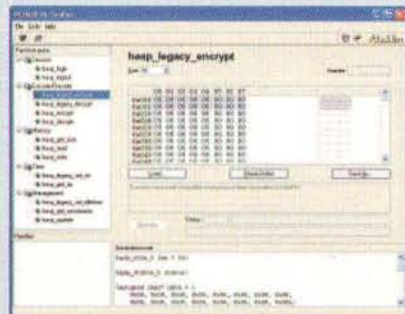
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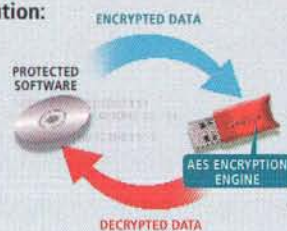
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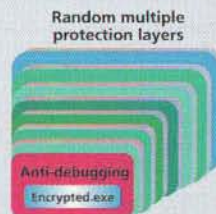
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Flexibility of tools and functionality	10%	93.3%	71.2%
Compatibility across platforms and environments	10%	93.3%	71%
Overall Evaluation		87.3%	69.8%



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Amazingly, these cards can go in a wide variety of older systems even beyond the PowerMac G4 that we're focused on for this series of articles. Specifically, Tempo Serial ATA can be used with Mac compatible computers including Power Macintosh Series 4400, 6400, 6500, 7200, 7215, 7220, 7300, 7500, 7600, 8200, 8500, 8515, 8600, 9500, 9500/180MP, 9515, 9600, 9600/200MP; Macintosh Server G3, G4; Power Macintosh G3 All-in-one, Blue & White, Desktop, Minitower; Power Mac G4, Power Mac G5, Performa Series 6400, 6410, 6420; Workgroup Server 7250, 7350, 8550, 9650; Daystar Genesis and Millennium Series; Mactell XB-Pro; Power Computing PowerBase Desktop and Tower, PowerCenter, PowerCenter Pro Desktop and Minitower, PowerCurve, PowerTower, PowerTower Pro, PowerWave; StarMax 3000, 3000 Minitower, 4000, 4000 Minitower, 5000, 5500; and UMAX C500, C600, C600X, J700, S900. Phew!

Cooling in a PowerMac G4 works fairly well, but nevertheless, it's always good to know what these cards require for an operating environment. The operating temperature ranges of Tempo Serial ATA are 5 to 55 degrees C. The operating and non-operating relative humidity ranges are 20 to 80 % and 15 to 90 %. The package of this product contains Tempo Serial ATA 2-Port PCI controller card, quick start guide, 1 Serial ATA data interface cable (22 inches), 1 legacy-to-Serial ATA power cable, and drive mounting screws.

Tempo eSATA data cables are designed to connect a SATA host controller such as Sonnet's Tempo SATA E4P, Tempo SATA X4P, Tempo-X eSATA 4+4, or Tempo-X eSATA 8 to Serial ATA drive enclosures. The cables feature external Serial ATA (eSATA) connectors, equipped with springs similar to USB, designed for over 5,000 insertions and removals. They are equipped with extra shielding and metal contacts for better EMI protection. Tempo eSATA data cables come in length of 1 meter and eSATA-to-eSATA, or eSATA-to-SATA I styles. SATA-2/1 connects a host controller card with eSATA connectors to an external drive enclosure with SATA I connectors. SATA-2/2 connects a host controller card with eSATA connectors to an external drive enclosure with eSATA connectors.



Tempo Serial ATA is priced at \$79.95 whereas Tempo eSATA data cable kit costs \$24.95. Both products come with 3-year limited warranty.

Gigabit Ethernet

In our scenario, we not only wanted Internet backups to happen, but also faster gigabit Ethernet connectivity. By adding in a Sonnet Gigabit card, we were able to focus the LAN backups over the faster gigabit Ethernet interface, while letting the connectivity over the Internet go over the built-in Ethernet interface.

Presto Gigabit is a 10/100/1000 Gigabit Ethernet PCI adapter card that is compatible with most PCI Power Macintosh configurations. Presto Gigabit is based on Sonnet's Simply Fast Design, making it easily installable. Presto Gigabit supports full and half-duplex communication and it features 1000/100/10BaseT auto-negotiation. Presto Gigabit features one RJ-45 connector that supports 1000Mbps, 100Mbps, 10Mbps network speed and Auto-MDI/MDI-X, and PCI V2.2/2.1, 32-bit, 66/33 MHz bus interface. Presto Gigabit supports IEEE 802.3 10BaseT, IEEE 802.3u 100BaseT, and IEEE 802.3ab 1000BaseT standards. Presto Gigabit supports transmission rates of 10Mbps/20Mbps, 100Mbps/200Mbps, and 1000Mbps/2000Mbps. The IRQ line and I/O addresses for Presto Gigabit are assigned by system.



Presto Gigabit

Like the Sonnet ATA and SATA cards, the Presto Gigabit can be used with a wide variety of computers similar to the other cards. Check the Sonnet web site for specifics on your model. Presto Gigabit is compatible with above listed Mac compatible computers running Mac OS X Version 10.2 or later. Presto Gigabit can also be used with Windows computers with available PCI slot, running on Windows 98SE, ME, 2000, or XP.

Presto Gigabit costs \$89.95 and it comes with 3-year limited warranty.

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Web Benchmarking 101

A guide to stress testing your website with ApacheBench and JMeter

By Jin Lin and Emmanuel Stein

Introduction

Web performance testing can be a daunting subject for the uninitiated. With the sheer number of tools available and their various feature sets, it can be hard to know where to begin. In this article we will explore the use of two popular open source tools, ApacheBench (aka `ab`) and JMeter, to perform simple benchmarking tests. Rather than going through the extensive feature set offered by these applications, particularly JMeter, we will focus on measuring the response time and the effective throughput of your web application across different user load scenarios. Whether serving a few static pages or a fully dynamic site, the tools discussed will offer invaluable insight into the overall performance of your web applications, and serve as a basis for isolating system bottlenecks and conducting capacity planning for your web applications.

Benchmarking Considerations

Although, the tests and tools that we will use in this article represent integral components used in the testing process, it is equally important to consider the environment in which such tests are performed. If you are running a popular website with significant traffic, you may consider performing benchmarks during non-peak hours to obtain more accurate results and avoid rendering your server unusable to users. If possible, you should test your web server in a staged environment and before actual deployment. This will enable you to adjust server parameters, install cache mechanisms, and otherwise assess your site's performance without interrupting service.

ApacheBench

ApacheBench, a default component of the Apache Server distribution, is a simple command line tool, designed to measure the performance of Apache server. Preinstalled on Mac OS X, it is able to supply information such as elapsed time, requests per second, time per request, compression rate, transfer rate, and connection time under different concurrence scenarios.

Though not an exhaustive list (see the `ab` man page for more details), the following represents the most commonly

used switches employed when testing typical usage scenarios with `ab`.

- `-n`: Specifies the number of requests to perform for a given test. Use this option to measure the time required to process a given number of client requests. When used alone, without the `-c` option, `ab` does not process requests concurrently.
- `-t`: Specifies a timeframe, in seconds, to spend benchmarking. This option is useful in determining the number of requests that your server is able to process in a given amount of time.
- `-c`: Specifies number of simultaneous connections. Of use in testing how your server performs when multiple clients are hitting a given page at the same time. This switch may be used with either `-n` or `-t`, to measure the total elapsed time required to process a given number of client requests simultaneously, and the number of concurrent requests that may be processed over a set amount of time, respectively.
- `-g`: Exports a TSV (Tab Separated Values) file, which can be imported into applications like Excel, GNUplot, and Mathematica for further analysis and/or graphic visualization.
- `-A`: Used to supply username and password information for sites that require authentication. This enables you to conduct testing on password-protected sites.

Having covered some of the basic parameters of `ab`, we will now explore its use in the context of simple web benchmarking scenarios.

For our first example, we will be measuring the time it takes to process 1000 requests (i.e. `-n 1000`), from 10 simultaneous user connections (i.e. `-c 10`) against OS X's default user website. Make sure Apache is running by launching System Preferences and enabling personal web sharing from the **sharing preference pane**. Once Apache is running, launch the Terminal application and enter the following command: `ab -n 1000 -c 10 http://localhost/~username` to begin

the benchmark. When the command is executed the terminal will display the progress of the benchmark run, as well as, a series of metrics (Figure 1).

```

Terminal — ssh — 86x54
macverse:~ estein$ ab -n 1000 -c 10 http://localhost/~estein
This is ApacheBench, Version 1.3d <Revision: 1.73> $> apache-1.3
Copyright (c) 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Copyright (c) 1998-2002 The Apache Software Foundation, http://www.apache.org/

Benchmarking localhost (be patient)
Completed 100 requests
Completed 200 requests
Completed 300 requests
Completed 400 requests
Completed 500 requests
Completed 600 requests
Completed 700 requests
Completed 800 requests
Completed 900 requests
Finished 1000 requests
Server Software:      Apache/1.3.33
Server Hostname:      localhost
Server Port:          80

Document Path:        /~estein
Document Length:      276 bytes

Concurrency Level:    10
Time taken for tests:  0.328 seconds
Complete requests:    1000
Failed requests:       0
Broken pipe errors:    0
Non-2xx responses:    1003
Total transferred:    436305 bytes
HTML transferred:     276828 bytes
Requests per second:  3048.78 [#/sec] (mean)
Time per request:     3.28 [ms] (mean)
Time per request:     0.33 [ms] (mean, across all concurrent requests)
Transfer rate:        1330.20 [Kbytes/sec] received

Connection Times (ms)
      min   mean[+/-sd] median   max
Connect:    0      0   0.1      0    4
Processing:  1      3   1.6      2   15
Waiting:    1      2   1.6      2   14
Total:      1      3   1.7      2   15

Percentage of the requests served within a certain time (ms)
 50%    2
 66%    3
 75%    3
 80%    3
 90%    3
 95%    5
 98%   11
 99%   14
100%   15 (last request)
macverse:~ estein$

```

Figure 1. Output of `ab -n 1000 -c 10 http://localhost/~estein`

Be aware that when you run the `ab` command against a domain or IP address the benchmark defaults to the site's home page; in this case, `index.html`. To specify a particular page, simply point to its full path (e.g. `http://localhost/~estein/MyDynamicContent.php`). This will allow you to test the performance of specific pages hosted by your site in terms of the amount of stress they each place on the server. This is particularly important when dealing with sites that have both static and dynamic content. When testing dynamic pages keep in mind that `ab` reports a failed request when it encounters content that changes over time (e.g. dynamic data). As such, when running `ab` against dynamic portions of your site, you can safely ignore the "failed requests" messages.

For our next example, we will be measuring the number of requests that can be completed within 60 seconds (`-t 60`) with 10 concurrent connections (`-c 10`). Enter the following command in the Terminal to execute this benchmark: `ab -t 60 -c 10 http://localhost/~username`. The output of this

command, seen in Figure 2, differs from the first example in that `-n` is not specified. When `-n` is not specified, `ab` sets the number of requests to a default value of 50,000. It is important to realize that, when using the `-t` switch, it is possible for the benchmark to complete, before the specified time period has elapsed, thus rendering the time variable irrelevant. Therefore, when using the `-t` and `-n` switches in tandem, it is important to consider whether your time variable exceeds the time it takes to process `n` requests.

```

Terminal — ssh — 83x48
macverse:~ estein$ ab -t 60 -c 10 http://localhost/~estein
This is ApacheBench, Version 1.3d <Revision: 1.73> $> apache-1.3
Copyright (c) 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Copyright (c) 1998-2002 The Apache Software Foundation, http://www.apache.org/

Benchmarking localhost (be patient)
Completed 5000 requests
Completed 10000 requests
Completed 15000 requests
Finished 16365 requests
Server Software:      Apache/1.3.33
Server Hostname:      localhost
Server Port:          80

Document Path:        /~estein
Document Length:      276 bytes

Concurrency Level:    10
Time taken for tests:  62.174 seconds
Complete requests:    16365
Failed requests:       0
Broken pipe errors:    0
Non-2xx responses:    16366
Total transferred:    7119210 bytes
HTML transferred:     4517016 bytes
Requests per second:  263.21 [#/sec] (mean)
Time per request:     37.99 [ms] (mean)
Time per request:     3.80 [ms] (mean, across all concurrent requests)
Transfer rate:        114.50 [Kbytes/sec] received

Connection Times (ms)
      min   mean[+/-sd] median   max
Connect:    0      0   0.4      0   12
Processing:  0      2   1.0      2   19
Waiting:    0      2   1.1      2   19
Total:      0      3   1.2      2   19

Percentage of the requests served within a certain time (ms)
 50%    2
 66%    3
 75%    3
 80%    3
 90%    4
 95%    5
 98%    8
 99%    9
100%   19 (last request)
macverse:~ estein$

```

Figure 2. Output of `ab -t 60 -c 10 http://localhost/~estein`

JMeter

JMeter is a pure Java application, developed under the purview of the Apache Jakarta project, which offers a wide array of tools for benchmarking all manner of client-serverbased applications. JMeter's modular architecture allows it to simulate a variety of load scenarios across multiple servers, networks, and objects. For the purposes of this article, however, we will only be using a subset of JMeter's capabilities to perform basic load testing. For information on using JMeter to perform detailed performance measures on more complex web applications you may refer to the user guide at <http://jakarta.apache.org/jmeter/usermanual/index.html>

Before we begin, it is instructive to go over the major architectural components that constitute JMeter.

- **Test Plan:** Defines the test sequence that JMeter will carry out during benchmarking.
- **Thread Group:** Used to delineate specific testing conditions, such as number of concurrent users, the Thread Group plays host to all other elements that comprise a test sequence.
- **Config Element:** Responsible for defining configuration information for the Sampler and Logic Controller elements.
- **Sampler:** A type of controller that designates both the protocol type and nature of requests within a given test plan.
- **Logic Controller:** A controller element that determines the sequence logic used by JMeter to initiate protocol requests.
- **Timer:** Used to manage the latency across queued user requests.
- **Listener:** Responsible for recording and visualizing of test sequence data.

Getting Started

JMeter requires JDK 1.4 or higher to run properly. Type `java -version` in the Terminal application to discover which version of JDK is installed on your machine. Currently Apple supplies Java 1.3.1-1.4.2 Release 2 and J2SE 5.0 release 3 through regular software updates, as well as, at the following links:

<http://www.apple.com/downloads/macosx/apple/java131and142release2.html>

<http://www.apple.com/downloads/macosx/apple/java2se50release3.html>

In our tests, both JDK versions were able to run JMeter without a hitch. However, you will likely notice some performance improvement when using the J2SE 5.0 release 3. To specify this version as your system default or to change the precedence settings for your installed Java Virtual Machines (JVMs), use the Java Preferences utility located in `/Applications/Utilities/Java/Java2SE 5.0`.

The latest version of JMeter is available as a free download at http://jakarta.apache.org/site/downloads/downloads_jmeter.cgi. Depending on your preferences, you can download the application as source code or binary as either .zip or .tgz archives. The easiest option for most OS X users will be to download the binary in zip format, which can be easily uncompressed in the GUI by double clicking the `jakarta-jmeter-2.1.x.zip` archive. The resulting `jakarta-jmeter-2.1.1` folder can be placed in your Applications folder or other location within the filesystem. You can launch JMeter by either double clicking the `ApacheJMeter.jar` file, located in the `bin` directory of the `Jakarta-jmeter-2.1.1` folder, or by executing the `jmeter` shell script located in the same directory. Please note, that if you wish to run `jmeter` from the command line you will need to make the script executable using the `chmod` command. For command line interactive use, please refer to the "Getting Started"

section of the JMeter user manual: <http://jakarta.apache.org/jmeter/usermanual/get-started.html>

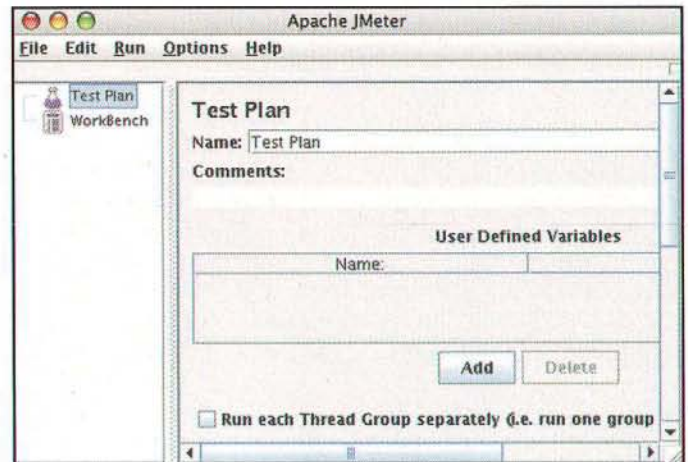


Figure 3. JMeter's main window

JMeter in Action

In this example, we will create a test plan that simulates 10 users initiating simultaneous requests to 2 different URLs and which repeats the test 100 times. Begin with the addition of a new Thread Group by right clicking (or control clicking) the **Test Plan** element in the left pane and selecting **Add > Thread Group**. Next, select the **Thread Group** element to display its configuration window and set the **Number of Threads** to 10 (representing users), the **Ramp-Up Period** to 0 (to initiate all users at once), and the **Loop Count** to 100.

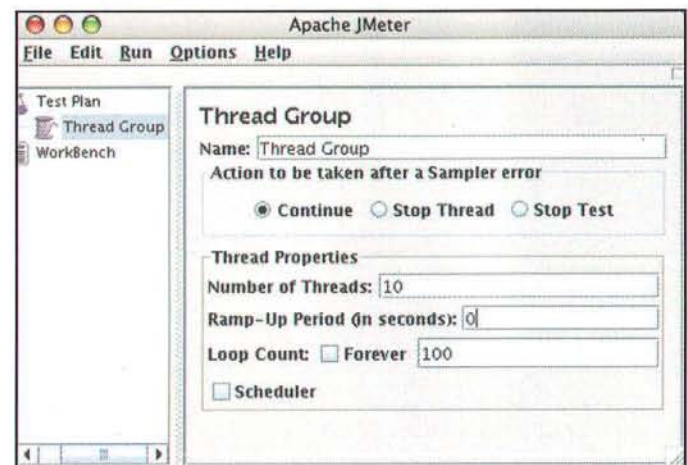


Figure 4. Configuring Thread Group element

To add the next element of our test plan, HTTP Request Defaults, right click on the **Thread Group** element, and select **Add > Config Element > HTTP Request Defaults** (Figure 5).

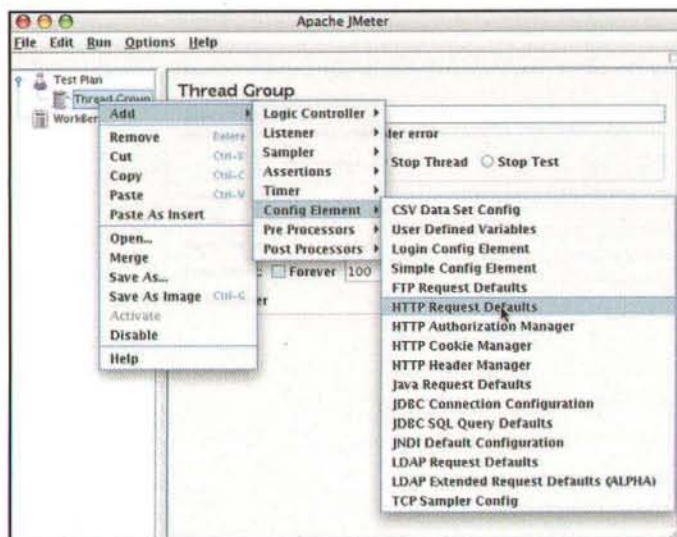


Figure 5. Add HTTP Request Defaults

Select the HTTP Request Defaults icon under Thread Group and enter a server name (e.g. localhost or FQDN) in the configuration window (Figure 6).

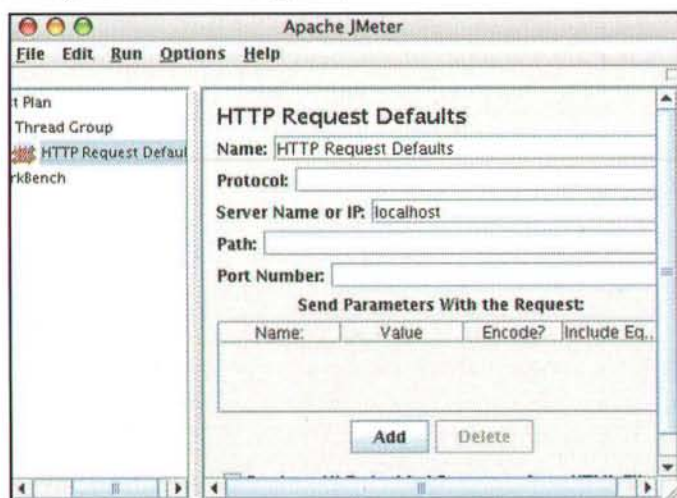


Figure 6. Configuring HTTP Request Defaults element

Right click on the Thread Group element and then select Add>Sampler>HTTP Request twice, to create two HTTP Request elements, one for each web page. The Name and Path fields for each of the HTTP Request elements should be set to appropriate values. For the purpose of this example, we will name the first HTTP Request element home, and set its path to ~username/index.html and name the second HTTP Request another and set its path to ~username/another.html (figure 7).

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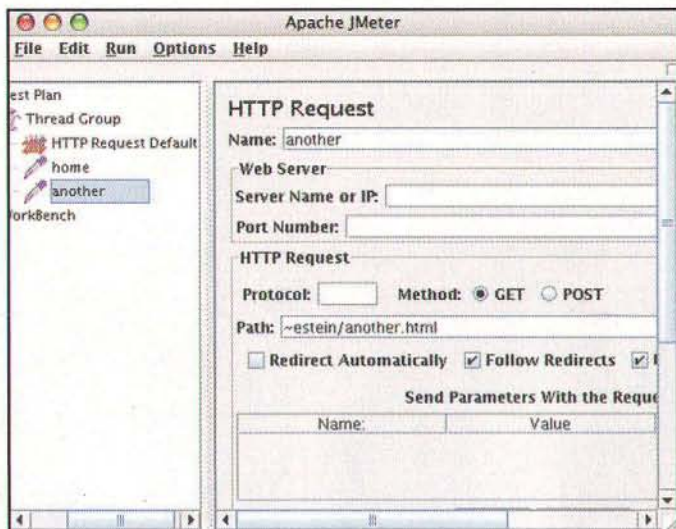


Figure 7. Configuring the “another” HTTP Request element

Now we need to add a timer to pause each request for a random period of time. Right click on the Thread Group and then select Add>Timer>Gaussian Random Time.

For the last element, we will add listeners by right clicking on the Thread Group element, then selecting Add>Listener>Aggregate Report. This particular listener lists, in tabular form, the response time, request count, min, max, average, error rate, and approximate number of request processes in seconds (e.g. Throughput), as well as, throughput in terms of Kilobytes per second. You may add additional listeners, such as Graph Results, View Results in Table, and View Results Tree, depending on your requirements.

To begin the test plan, simply select Run>Start from within the JMeter menu bar. You will be prompted to save the test plan, if you haven't already done so. During a successful run of your test plan, you may click on the Aggregate Report listener element (figure 8), or any other listener types you may have added, to view your dynamically updated test results. Figure 9, for example, demonstrates some of the graphing functions of JMeter's Graph Results listener element.

The screenshot shows the 'Aggregate Report' listener window. It has a title bar 'Aggregate Report' and a name field 'Aggregate Report'. There are buttons for 'Write All Data to a File', 'Browse...', 'Log Errors Only', and 'Configure'. Below is a table with the following data:

URL	# Samples	Average	Median	90% Line	Min	Max	Error %	Through...	KB/sec
home	1000	4	1	2	0	1445	0.00%	16.0/sec	90.02
another	1000	3	1	2	0	1440	0.00%	16.0/sec	89.80
TOTAL	2000	4	1	2	0	1445	0.00%	31.8/sec	178.75

Figure 8. Aggregate Report listener view

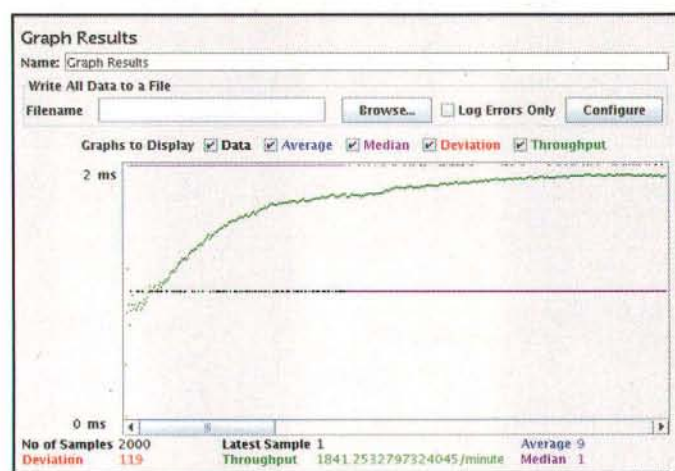


Figure 9. Graph Results listener view

Conclusion

In this article, we employed both ab and JMeter to “stress test” a locally hosted site via simple load scenarios. The amount of time a server takes to respond to clients' requests across different load levels, is one of the most important metrics for evaluating web performance. Through the manipulation of load test variables, such as the number of concurrent requests, and with reference to tool-specific data visualization processes, we are better able to ascertain the extent to which these variables impact a server's maximum sustainable load. Such information is critical for proper website management, planning and eventual performance tuning.

MI

About The Authors

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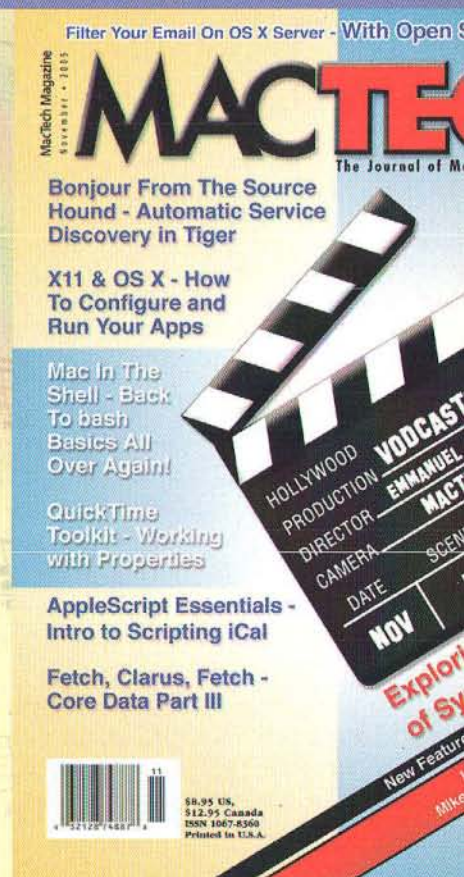
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TEXTMATE 1.5 REVIEW

Macromates, the creators of TextMate, calls it “the missing editor” with a nod to “The Missing Manuals” made popular by David Pogue. I would agree with their other tag line as well, that TextMate truly is “code and markup brought to the 21st century.” But what exactly is all the buzz about this text editor that popped out of nowhere to take Ruby on Rails developers by storm, and is now spreading like wildfire to other programmers, hackers and geeks alike? Let’s take a quick look at how I discovered it and then delve into the details that make TextMate so enticing.

Introduction

I first noticed TextMate in the early Fall of 2005. I found it by watching a Ruby on Rails screencast which seemed to be hard to follow as the developer was so quickly making text snippets appear on the screen and typing over (and through) them. Although it took some time and some Googling, I finally figured out how text editor was being used. I visited the TextMate web site, downloaded the 30-day trial version and started playing with it. Initially, I was excited with having found something new and after reading the hype on the web site, I felt like this might be something that would reinvigorate me. You know how, sometimes, you just need a new application for no particular reason. However, after a day or two of playing with it (without reading the manual), I decided it wasn’t for me – “too much new stuff to learn,” I thought. I was primarily using PHP, XHTML and SQL, and although it supported those languages, all the talk was Ruby Ruby, Ruby. I felt left out.

Fast-forward to the winter of 2005, when I came across TextMate again. This time I noticed it had grown up a bit. In fact, version 1.5 had just been released, so I decided to give it another try. This time I read the online manual and watched some of the new screencasts to see how others were using it. I was extremely impressed with the power behind this young text editor. So much so in fact, that I paid for it this time, and have been using it daily ever since. By leveraging the power of plug-in-like modules called bundles and interfacing with the power of the UNIX command line, Allan Odgaard had created a very capable application that could increase productivity all the while making it fun to use. Yeah, that’s right, it’s simply fun to use.



Figure 1. TextMate in action editing HTML code

TextMate is built on bundles. In version 1.5 there are over 30 bundles that define how TextMate behaves for any particular file type or language. Each bundle contains any number of 7 different types of items. These items consist of commands, drag commands, macros, snippets, languages, preferences and templates. All bundles (and their subsequent items) are completely customizable. You can edit what’s already there, create your own or download those created by other users, essentially making TextMate infinitely extensible. Mind you,

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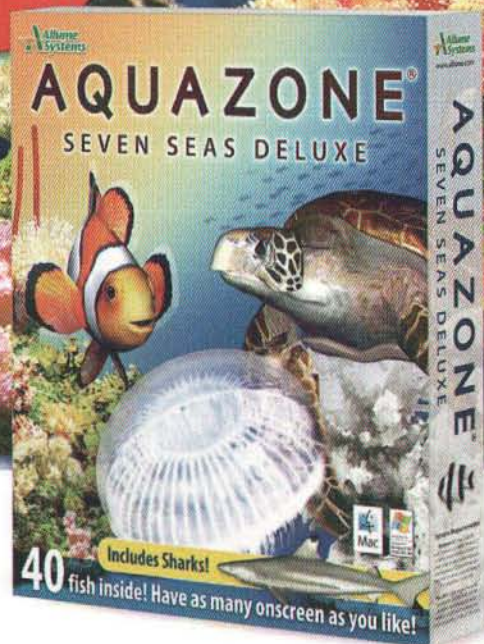


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creating a TextMate bundle is not for the faint hearted, but, it is for geeks. Some of the default bundles include those that help you work with Apache, C, CSS, HTML, Java, JavaScript, LaTeX, Markdown, Objective-C, Perl, PHP, PHPDoc, Python, Rails, Ruby, SQL, Subversion, Textile, XML, and YAML. There are also more generic bundles that handle non-language-specific tasks such as Diff, Source, UNIX Shell and Web Searches. Other bundle items assist with unit testing in both Java and Ruby.

Bundle items are triggered in various ways throughout TextMate. Languages are automatically chosen based on the file suffix of the currently active file and the location of the insertion point within the file, but more on this later. Drag commands are triggered when a file is dragged and dropped into an editor window. We'll see an example of this as well. Templates allow you to create new documents based on their contents. Commands, macros, and snippets are triggered either from the gear menu (See Figure 2) at the bottom of any editor window or by typing text and/or typing special trigger keys. For example, in a PHP code block, typing the word `foreach` and pressing the tab key spits out an entire `foreach ($variable as $key => $value) { }` block of code. Even more amazing, is that, the word `variable` is pre-selected allowing you to type the real name of your variable over it. TextMate calls this functionality placeholders. Pressing tab again selects key allowing the same type-over capability. This functionality continues for value and the middle of the `{ }` characters. The bottom line is that you save over a dozen keystrokes using this

handy shortcut. TextMate is filled with hundreds of these little enhancements to your personal workflow.



Figure 2. The gear menu showing text commands, macros and snippets.

Let's take a look at a bundle in more detail to see what TextMate has to offer.

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The HTML Bundle

The HTML bundle (see Figure 3) is a good example to discuss because many readers are familiar with HTML and the bundle itself contains at least one of each aforementioned bundle item. This will give you a good idea of not only what is possible with TextMate today, but, how you can extend it for your own needs. However, note that when you download TextMate and try it for yourself (and you will if you haven't already) you can easily explore other non-HTML bundles that make sense for the work you do.

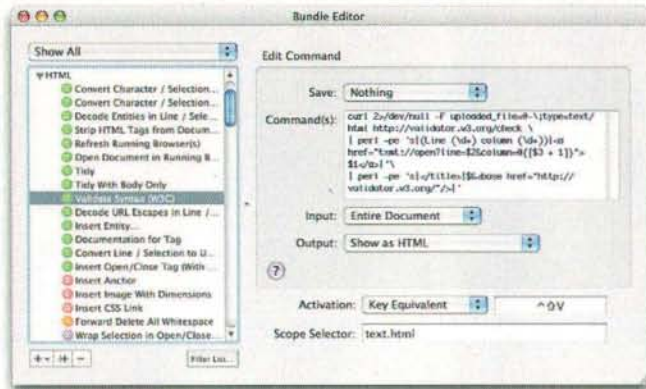


Figure 3. The bundle editor showing some of the contents of the HTML bundle

Commands

Commands in TextMate are scripts interpreted by bash or whatever interpreter you specify including Perl, PHP or Ruby. The scripts can take the entire current document, the selected text, or, nothing as input. The output can replace the current document, replace the selected text, be shown as a tool tip or a variety of other options including being discarded altogether. Commands can also optionally save the document before executing. As stated earlier you can also set a key equivalent for any command or a tab trigger (like our `foreach` example). Commands can also be programmed to request user input much like AppleScript uses dialog boxes. Command progress can also be displayed using percentage or barbershop pole progress indicators.

Commands are very powerful in that, they can execute any script that you can call from the command line Terminal application, alongside complete interaction with the data in TextMate. You can perform tasks as simple as displaying (or inserting) the uptime in a TextMate document, or, as complex as `grep`-ing the selected line of text for a zip code, accessing an outside data source (such as a web site) to look up the name of the city and state for that zip code. The rest of the line of text can be verified, making any necessary corrections automatically. The possibilities are practically limitless, and, in essence make TextMate a very open application. Other commands built into TextMate include calculator functionality in the Math bundle, as well as software version control in the Subversion bundle. You

can even control Apple's Xcode from TextMate with commands in the Xcode bundle.

Looking at a specific example, in Figure 3 we see the **Validate Syntax** command, which can be triggered by typing control-shift-V or by selecting the item from the HTML submenu of the gear menu. You can see that this command consists of a call to the command line application `curl`. By extracting the text of the entire document and passing it to the `w3.org` website via `curl` and then displaying the HTML results in a separate window, TextMate affords us a simple way (meaning no excuses) to check the syntax of our HTML documents quickly.

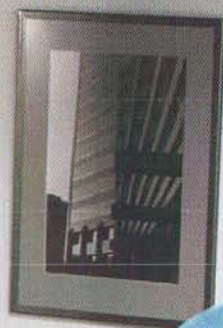
You may think that with so many commands and so many possible key equivalents that you will have trouble keeping it all, straight. Well, the good news is that TextMate is very intelligent when it comes to managing scope. As we'll see in the definition of language items below, key equivalents and tab triggers only apply in the specific scope that the bundle determines. Therefore, the PHP `foreach` example we showed earlier will not work if you are in a SQL file, for instance. Given this fact, you can re-purpose key equivalents as appropriate. A perfect example is control-H. TextMate implements control-H in a variety of bundles to look up documentation for the selected text. In HTML, control-H looks up the selected element on `w3.org`. When triggered in a Perl file the selected text is looked up on `perl.org`. No matter where the documentation comes from, TextMate displays it in a separate window saving you a trip to your browser. However, in the case where you do use the same key equivalent for multiple commands, TextMate merely pops up a menu with all the choices through which you can easily scroll, and make the proper selection.

Drag Commands

Drag commands are very similar to regular commands with the exception that the method that triggers them is dropping a particular file type into a TextMate document. For example, the HTML bundle contains a drag command named **Insert Image With Dimensions**. It is set to trigger whenever the user drops a png, jpg or gif file into the document. When this occurs, the drag command is executed and inserts a complete `img` tag into the document with `src`, `height`, `width` and `alt` tag information entered automatically. One of the many attentions to detail seen throughout TextMate is apparent in this example, in that, when you drag a file named `figure_1.png` the drag command creates an `alt` tag with the value "Figure 1." TextMate automatically converts the underscore to a space and properly capitalizes the text.

This particular drag command works by calling the `sips` command line tool built into Mac OS X to extract the height and width of the dragged file and then inserts the completed `img` tag into the text file at the location of the drop. One thing you will notice by looking at the actual code behind many of TextMate's commands is that it makes use of other command line tools (such as Perl, PHP and Ruby) to parse text and perform other actions pertinent to the task at hand. TextMate makes use of all of the available power under the hood to make your work easier.

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Macros

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To insert the previous paragraph of text I merely typed the word `lorem` and then pressed the tab key. This is a very simple macro but the macro capability in TextMate is much more than this. TextMate allows you to record a macro by selecting **Start Macro Recording** from the **Automation** menu. Once macro recording has begun, it will capture all text editing, usage of the **Find** menu command, running other commands as discussed above, inserting snippets, etc. The macro will then appear in the bundle editor and allow you to attach it to whichever bundle is appropriate, as well as, set key equivalents, triggers, and other settings. Once a macro is recorded it cannot be edited.

Snippets

Normally when you think of a snippet, you probably think of a static piece of text that you can quickly insert in a document. Many times this is done using copy and paste, copying the snippet

from your repository of said snippets and pasting it into your working document. As you may expect by now, TextMate takes this expected functionality and spins it around a few dozen times with little regard for the fact that it may have just eaten.

A snippet in TextMate can be static text but it can also include code that can be run when the snippet is inserted. The snippet can also contain variables, such as the selected text at the time of the insertion. This essentially gives snippets the ability to wrap the selection in whatever other text you so desire. Snippets can also contain placeholders for missing information which you can then tab through and replace, such as the PHP `foreach` example we discussed earlier. The snippet can also perform transformations on the data you enter within the placeholder. These transformations can take the form of regular expressions, calls to command line utilities or execution of shell scripts.


One particularly good example of using placeholders and transformations is in LaTeX. Consider this, instead of typing the line of text `\section{Introduction to Music}\label{sec:introduction_to_music}`, TextMate allows me to do the following: Type the word `sec` and press the tab key. This inserts the text `\section{section name}\label{sec:section_name}` replacing where I typed `sec` and highlights the words `section name`. I can then type over those words to set my section name, in this case `Introduction to Music`. All the while I am typing the mixed-case text `Introduction to Music`, TextMate is inserting the same text in all lowercase underscored format where the `section_name` text appeared originally. Pressing the tab key selects the lowercase underscored version allowing me to type over that if I so desire, and with a final tab press moves the insertion point to the next line. The bottom line being that TextMate allowed me to type in 27 characters that in a normal text editor would have taken me 65 characters.

The HTML bundle contains numerous snippets that handle everything from inserting head, title, meta and script tags to tables, forms, anchors, and embedding movies. For instance, typing the word `movie` and pressing tab, inserts 10 lines of code with the `src` of the movie pre-selected for you to replace if needed. Tabbing allows you to alter the various parameters of the embed tag quickly and easily. Once you create a few forms using this abbreviated entry method (typing and tabbing) you will be forever changed and save countless keystrokes. Not only does it make the typing itself faster and more accurate, but, also saves you from having to recall potentially obscure attribute names within a tag since they are already included in the snippet.

Languages

Languages, or language grammars, are the items in a bundle that help TextMate decide what, within a block of text is a keyword, comment, variable, or string. The information gleaned from this item allows for syntax highlighting and to make the editor smart about which context the insertion point is located. As mentioned earlier, this is how TextMate knows when you type `control-H`, if you are looking up an HTML tag or a PHP keyword. Language grammars are used to parse documents and

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assign the proper scope to any particular position within the text. Everywhere else throughout TextMate, this information is used to narrow down functionality based on a particular scope. Although delving much deeper into language grammars, is well beyond the scope (no pun intended) of this review, suffice it to say that TextMate offers you the capability to implement any language that you may need that isn't already packaged with the product. For instance, if you have a custom text-based file format you can create your own grammar for it and further create commands, macros, snippets, templates, and more. The language grammar item is the crux of the bundle.

Preferences

Preference items in a bundle are useful should you need to manipulate functionality based on scope within a document. For example, should you need to alter matching pairs of characters (such as `{` and `}`) or patterns that require text to be indented or outdented, based on where you begin typing (such as for text within a function declaration), this is the place to do it. Mind you, TextMate doesn't give you checkboxes and pop-up menus to set these options. It's all typing in text as in Figure 3, but the power is there.

Templates

Templates are shells of text that allow you to quickly create a new file based on the template, no surprises here. A bundle can contain any number of templates, for example, the HTML bundle contains templates for XHTML 1.1, XHTML 1.0 Strict, XHTML 1.0 Transitional, and XHTML 1.0 Frameset documents.

Other Features

Beyond the realm of bundles TextMate has dozens of other features. Some are staples, while some are unique extras. Let's take a look at some of the highlights.

Projects and Tabs

TextMate supports the concept of a project. The easiest way to work with projects is to drag an entire folder over the TextMate icon in your dock and TextMate will open a tabbed window with a project drawer open to the side. The project drawer displays the file hierarchy of your project folder and as you click on files in the drawer, opens them as tabs to be edited. The tabs can also be rearranged at will.

Color and Style Themes

TextMate supports syntax highlighting, including a very intricate engine that allows you to choose a different font style for each scope selector. In reality this can make for some very busy color schemes, but, if used for good and not evil you can come up with some pleasing combinations as well. TextMate ships with a dozen or more themes and users submit themes to the Wiki on a regular basis. However, be warned, all of the time you save, actually using TextMate can be gobbled up by tweaking the settings in this preference.

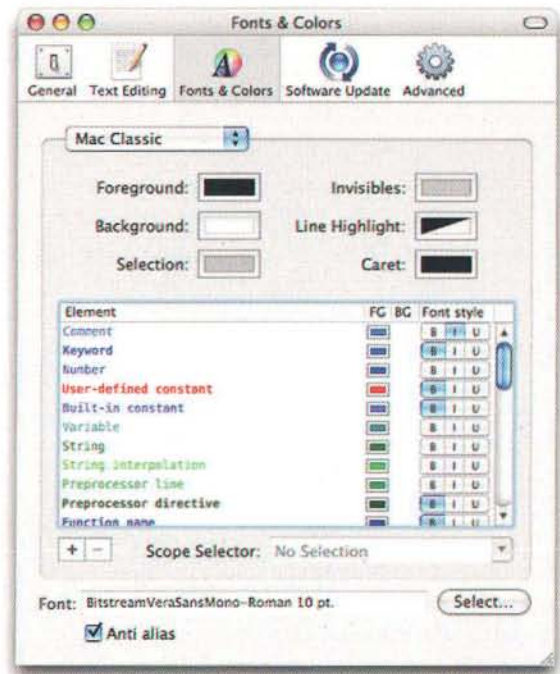


Figure 4. The theme editor Folding

Folding, the ability to collapse portions of your document, is also available as can be seen in Figure 1. Note on line 5 that the head tag is collapsed so you cannot see lines 6–10. However, hovering your mouse cursor over the ellipsis icon will display the collapsed contents in a tool tip. Folding can come in handy if you have sections of code, that do not need your attention at the moment, and, getting rid of them makes for less scrolling and easier editing. TextMate even remembers foldings after a document is closed.

Editor Pop-up Menus

At the bottom of the editor window are a series of pop-up menus including the gear menu, which gives access to commands, macros, and snippets, as well as, a function pop-up that displays a parsed list of entities in the current document. I say entities because for source code this might include classes, functions, methods or procedures, but, for HTML it may more likely contain element ids of divs and form inputs.

Smart Typing

TextMate has a **Smart typing** preference that can be enabled or disabled. This performs such tasks as balancing characters while typing, by inserting matching closing characters. That is, if you type a `{` it will type the matching `}` for you and let you continue typing the text in between. Matching character pairs themselves, are configurable via the bundle preference items for the current context.

Web Preview

TextMate has a built-in web preview window that uses WebKit built into OS X. This is no big deal really, and normally I wouldn't find myself using this feature, since I always have Safari and/or Firefox open when working on web sites. However, it does have one feature that makes it very nice. The **refresh after change** setting allows you to see changes to your document in the web preview window as you make them. That is, as you type HTML code, the changes are immediately displayed, as they would appear in a web browser. This, saves you having to change to another application and press the reload button while working on a table, stylesheet or form, and can be a big time saver.

Filter Through Command

Another very powerful feature, is the **Filter Through Command** menu item (see Figure 5). This allows you to type in any command that can be executed in the Terminal application, and filter the selection or the entire document through that command. The output can be displayed back in the document, as a tool tip, in a web preview window or in a new document. Need to sort a selection of columns? Simply run the selection through the `sort` command. Need to add line numbers to the text itself? Use the `cat -n` command. Want to encrypt the text as base64? Use the `openssl base64` command. The possibilities here, are endless.

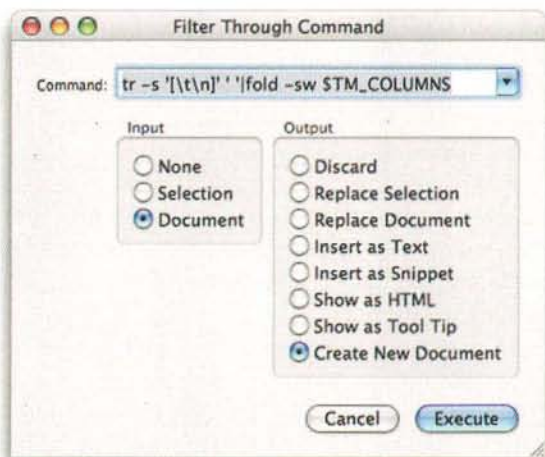


Figure 5. The Filter Through Command dialog box

Miscellaneous Editing Features

TextMate contains all sorts of nice editing features including columnar editing, spell checking, the ability to automatically indent pasted text, overwrite mode, and clipboard history, allowing you to copy multiple items in a row, and then paste them in another document in LIFO-style. Also, if you happen to be on the command line manipulating some files, and have a quick need to

edit something in TextMate, simply type `mate filename`, and the TextMate command line helper application will open the file in TextMate for editing.

But What's Wrong With It?

TextMate is not perfect, although it might seem like it. It is young, and has some growing up to do. There are a handful of things that I personally have trouble with, including the fact, that it's a little slow with really large files, and it takes at least a split second for syntax coloring to take effect, whenever you open any size file. TextMate only supports tabbed windows when using what it calls a project. This makes using tabbed windows, when editing remote files via SFTP impossible, unless you mount the remote server as WebDAV or some such. But then, that ends up being too slow for real work in many cases. It doesn't support splitting windows. Some of the language definitions still need some work (XML, for example) but since these are user-editable it's hard to complain about something like that. Sometimes the smart typing is not my kind of smart, so I've disabled it in my copy. Also, every once in awhile I'll come across a series of text that doesn't quite parse properly, usually when there are nested comments or comments in different languages in the same file. However, in the two distinct cases I can recall, it was a matter of changing the comment style from `/* */` to `//` (for example in PHP), and it fixed it even though `/* */` worked elsewhere. With all of the things that TextMate does right, I'm willing to live with the shortcomings because the developers are very responsive to feedback, and I expect in due time these issues will be addressed.

Conclusion

It may take some practice to become proficient, using TextMate. Having said that, it is also a fresh look at the future of text editing. TextMate takes text editing to a new level. The keyboard-oriented power of editors, like vi and emacs, with a Mac OS X graphical user interface, allows you to find new ways to optimize your work habits, almost every time you use it. If you have trouble along the way, there is a growing TextMate community available for support on the web, via email and IRC in the `##textmate` conference room. Also, the online manual contains many details on how to make the most out of all of the features reviewed in this article, plus more. If you value your time, and editing text is crucial to your work you should give TextMate a look. At 39 Euros, and a free 30-day trial you have little to lose, except a few thousand keystrokes. You can learn more about TextMate at <http://www.macromates.com/>

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About The Author

Joe Zobkiw is a software developer who has been using the Macintosh since 1986. He has written two books and numerous articles on Macintosh programming. He can be reached via zobkiw.com

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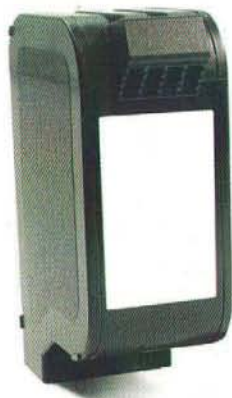
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INTRODUCTION TO SCRIPTING FILEMAKER PRO

For the past couple of columns, we have discussed various ways to store and access data using AppleScript. One column provided an introduction to Database Events, a background application in Mac OS X 10.4 and higher, which allows AppleScripts to interact directly with SQLite databases for the purposes of storing and accessing data. Another column explored methods of storing and accessing data in script properties and property list files. This month, we are going to continue discussing data storage and access, this time, using FileMaker Pro, a third-party commercial database application.

For the purposes of following along with this month's column, if you do not own FileMaker Pro, you can download a fully functional 30-day trial from <http://www.filemaker.com/>

All AppleScript code covered in this month's column was written and tested with FileMaker Pro version 8.0.1. Therefore, some of the AppleScript terminology discussed, may not function with older versions of FileMaker.

A FileMaker Pro database, named *Super Heroes*, is referenced throughout this month's column. See figure 1. You may download a copy of this database from <http://www.automatedworkflows.com/files/demos/MacTECH.03.06.Example.zip>. This example database is password protected with an account name of *Admin* and a password of *heroes*.

Working With Databases

Accessing and Opening Databases

The first thing we will discuss, is general database interaction. When scripting FileMaker Pro, the first thing you will probably want to do, is make sure that your target database is opened. This can be done by first checking to see if the database exists, as demonstrated by the following example code.

```
tell application "FileMaker Pro"
  database "Super Heroes" exists
end tell
-> false
```

If the desired database is not opened, then you may need to write code to open it. This is done by using the open command, followed by the path to the database file that you want to open. When using

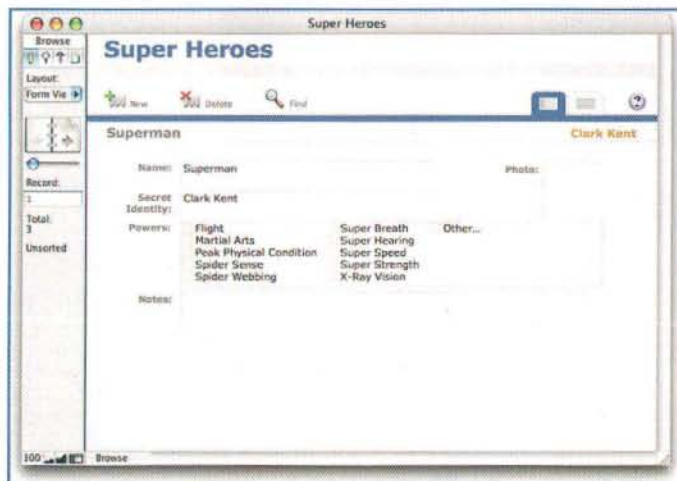


Figure 1. Example FileMaker Pro Database

the open command, you may optionally specify values for the Accounts and passwords parameters, if the database requires an account name and password. These parameters are pluralized because the open command may also be used to open one or more database files. If multiple databases are to be opened, then a list of databases, along with a list of account names and passwords, may be passed to the open command as parameters.

The following example code demonstrates how to open a single database with a specified account name and password.

```
set theDatabase to
choose file with prompt
"Please locate a
FileMaker Pro database
file to open:"
```

```
tell application
"FileMaker Pro"
  open theDatabase for
Accounts "Admin" with
passwords "heroes"
end tell
```

In some cases, your database may already be opened, but may simply be hidden from view, or be behind another database. To show a database, or bring it to the front of any of other visible database windows, you may use the show command. For example:

```
tell application
"FileMaker Pro"
  show database "Super Heroes"
end tell
```

While FileMaker Pro has a show command, it does not have a hide command. However, FileMaker Pro will allow AppleScript to interact with its menus, with the use of the do menu command. Using this method, you can hide a database by triggering the **Hide Window** menu item, which can be found under the **Window** menu. The following example code demonstrates how to do this.

```
tell application "FileMaker Pro"
  do menu menu item "Hide Window" of menu "Window"
end tell
```

A count command may be used to determine the number of currently opened databases. This includes any opened, but hidden databases. For example:

```
tell application "FileMaker Pro"
  count databases
end tell
```

```
end tell
→ 3
```

The following example code demonstrates how to retrieve the name of every opened database.

```
tell application "FileMaker Pro"
  name of every database
end tell
→ ("MyDB1.fp7", "MyDB2.fp7", "Super Heroes.fp7")
```

FileMaker Scripts

In addition to supporting AppleScript interaction, FileMaker Pro also has its own internal scripting capabilities. Through FileMaker Pro's interface, you can create scripts, and attach them to a database. FileMaker Pro scripts can be triggered in a variety of ways, such as when a database is opened, when a user clicks a button, and so forth. These scripts are not to be confused with AppleScripts. Again, they are internal to FileMaker only, and cannot interact with

external applications or processes. See figure 2 for an example of a FileMaker Pro script that will display a custom dialog message, using values from various fields in the database.

As you begin automating FileMaker Pro, you will learn that some tasks cannot be automated using AppleScript alone. For such tasks, utilizing a combination of AppleScripts, and FileMaker Pro scripts, can usually get the job done. FileMaker Pro scripts can be triggered from AppleScript with the use of a do script command. For example:

```
tell application "FileMaker Pro"
  activate
  tell database "Super Heroes"
    do script "Test"
  end tell
end tell
```

Figure 3 shows the result of using AppleScript to trigger the custom dialog FileMaker Pro script that was shown in Figure 2.

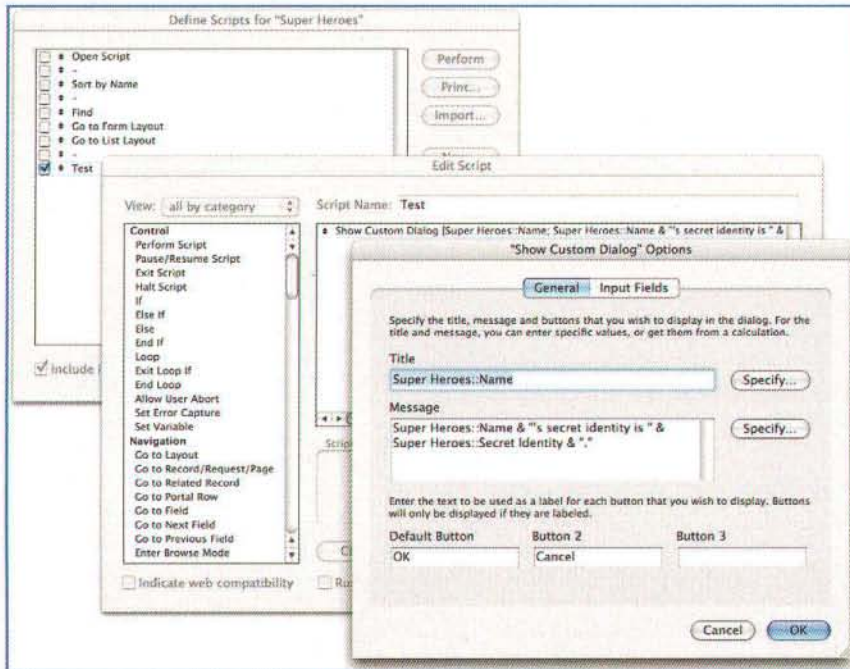


Figure 2. An Example of an Internal FileMaker Pro Script

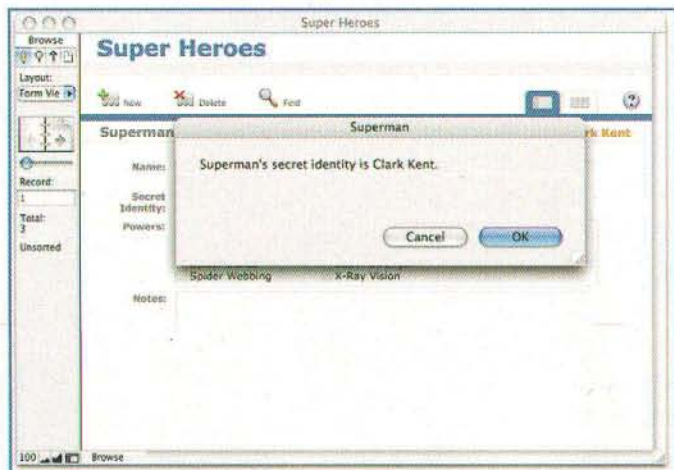


Figure 3. A Triggered FileMaker Pro Script

FileMaker Pro scripts can also be configured to trigger AppleScripts. This is done through the use of a *Perform AppleScript* FileMaker Pro script. See figure 4 for an example of a *Perform AppleScript* script that triggers AppleScript code to empty the trash in the Finder.



Figure 4. An Example of the Perform AppleScript FileMaker Pro Script

Tables

Prior to FileMaker Pro 7, a database file was comprised of a single table of data. FileMaker Pro 7 introduced the ability to include multiple tables within a single database file. Because of this, if you are scripting a database that contains multiple tables, you may need to specify the table, with which you want to interact in your database. This can be done with the following syntax.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    tell table "Super Heroes"
      -- Add code here
    end tell
  end tell
end tell
```

By default, if no table is specified, then any commands sent to the database will be directed to the first table in the database. This is demonstrated in the following example code.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    -- Add code here
  end tell
end tell
```

Therefore, if your database contains only a single table, then it is not necessary to specify a table in your AppleScript code. Rather, it is understood that all commands will be directed to the first table in this database.

Throughout this column, we will refer to our sample database without specifying a table. This is because, our sample database does not contain multiple tables.

Working with Records (Part 1)

Now that we have discussed database interaction, tables, and scripts, let's move on to the central focus of scripting FileMaker, interacting with the records of a database. When scripting FileMaker, you will most likely want to extract data from, or, populate data into the records of a database during execution of your script. Let's take a look at records.

Accessing Records in a Database

To count the records of a database, you can use the `count` command in the same way that we counted opened databases. For example:

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    count records
  end tell
end tell
-> 3
```

Please note that the code above will return the total number of records within the entire specified database. That said, many times, you might not want to count the records of the entire database. In some situations, a find may have been performed in the database, and you might want to determine how many records are contained within the current found subset of records. To do this, rather than referring to the database class when counting records, you can refer to the document class. For example:

```
tell application "FileMaker Pro"
  tell document "Super Heroes"
    count records
  end tell
end tell
-> 1
```

Distinguishing between the document and database class, can sometimes seem a bit confusing, but here are some general rules for when you should use each construct. When you want to refer to records within the scope of the entire database, you should utilize the database class. When you

Q: What do all these
Macintosh all-stars
have in common?



Scott
Kelby



Robin
Williams



Jim
Heid



Maria
Langer

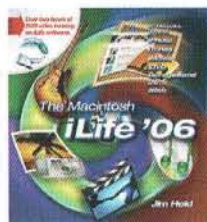
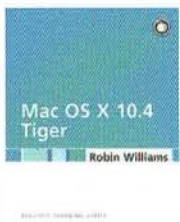
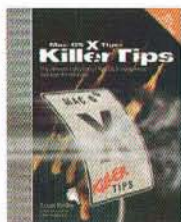


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want to refer to records within a found subset of records only, you should utilize the document class.

To navigate to a specific record in a database, you may use the show command. For example, the following code will locate and display the second record in the entire database.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    show record 2
  end tell
end tell
```

In the example code above, we specified an index number for the targeted record, in this case 2. An index number refers to the beginning to end positioning of a specified item. In this case, a record with an index number of 2 refers to the second record in the database. In many cases, locating a record by its index may meet your needs. However, keep in mind that a record's index number may change in certain situations, such as when a previous record is deleted. For example, if we were to delete the first record in my database, then record 2 would become record 1, and, therefore, it would have a new index number.

In FileMaker Pro, records also contain unique record ID numbers. These ID numbers are internal to FileMaker, and are assigned to records when they are created. Once an ID has been assigned to a record, it will not change. Therefore, a more accurate way of referring to a record would be to use its ID. To determine the ID of a given record, you may access the ID property of that record. For example, the following code will retrieve the ID number of the second record in the specified database.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    ID of record 2
  end tell
end tell
-> 3.0
```

Once you have the ID number for a record, then you may refer to that record by using its ID. For example, the following code will find and show a specified record, using its ID, rather than its index number.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    show record ID 3.0
  end tell
end tell
```

Creating Records

In some cases, rather than accessing an existing record, you may need to create a new record in a database. This is done by using the create command, and specifying in which database you would like to create the record. The following example code demonstrates the proper usage of this command.

```
tell application "FileMaker Pro"
  create new record at database "Super Heroes"
end tell
-> record id 4.0 of table "Super Heroes" of database "Super Heroes.fp7" of application "FileMaker Pro"
```

As you can see from the code above, the result of the create command, is a reference to the newly created record. This information could be placed into a variable for later usage in your script.



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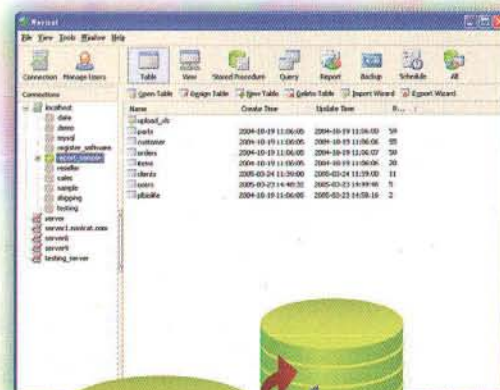
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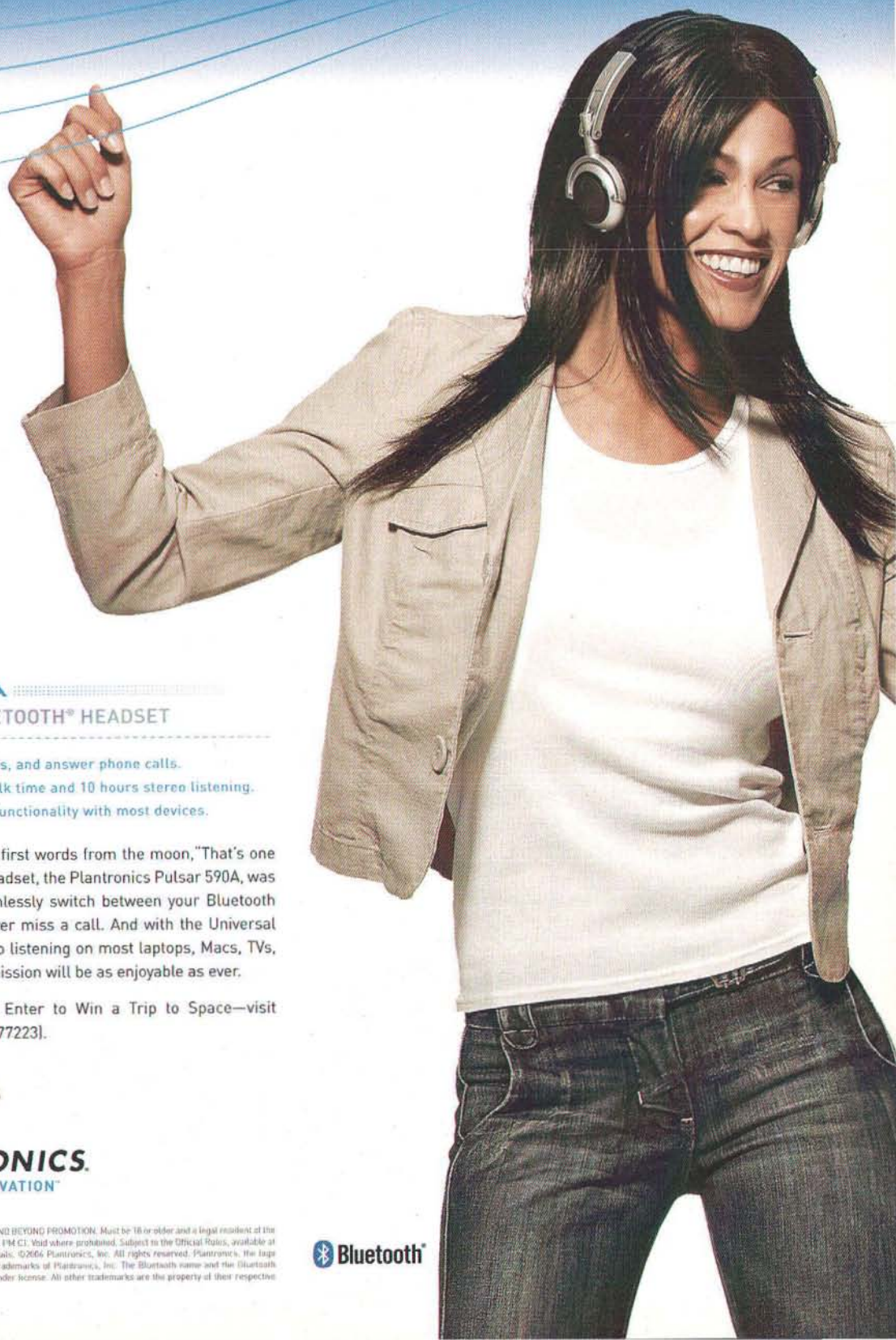
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Deleting Records

There may also be times when you need to delete records in your database. This can be done by using the delete command. The following code demonstrates how to delete a specific record of a specified database.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    delete record 3
  end tell
end tell
```

As another example of the delete command, the following code will delete every record in a found subset of records, within the specified database. Notice that, since we want to interact with a found subset of records, the document class is referenced, rather than the database class.

```
tell application "FileMaker Pro"
  tell document "Super Heroes"
    delete every record
  end tell
end tell
```

Working with Fields

When manually creating a FileMaker Pro database, one of the first things you will do is add fields for the different types of data that your database will hold. For example, our sample database, *Super Heroes*, contains *Name*, *Secret Identity*, and *Powers* fields, among others. FileMaker Pro's AppleScript dictionary defines two classes for use when interacting with fields.

First, a field class pertains to the actual fields within the context of a database itself, and not within the context of a

specific record within that database. This can be illustrated through the following two code examples.

This first example will count the fields within our sample database. Since there are 8 fields in this database, the result of this example code is a value of 8.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    count fields
  end tell
end tell
-> 8
```

This next example will attempt to count the fields within a specific record of our sample database. Since fields are not contained by records, this code results in a value of 0.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    tell record 1
      count fields
    end tell
  end tell
end tell
-> 0
```

The second class that is defined for interaction with fields in a database, is the cell class. In FileMaker Pro, databases contain fields and records. Records contain cells, which contain data and correspond to fields. The following example code shows that counting the number of cells within a specified record in our sample database returns a value of 8.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    tell record 1
```



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```

        count cells
    end tell
end tell
end tell
-> 8

```

Retrieving Field Contents

Now that we have discussed different ways to refer to fields, let's discuss how to retrieve data from fields. To retrieve the contents of a field within the scope of a single record, refer to a specific cell class contained within that record. For example, the following code will retrieve the value of the *Name* field for the first record in our database.

```

tell application "FileMaker Pro"
    tell database "Super Heroes"
        tell record 1
            cell "Name"
        end tell
    end tell
end tell
-> "Superman"

```

As you can see by the code above, it is not actually necessary to reference a parameter of a cell in order to retrieve the cell's value. Simply referring to the cell itself will result in the value of that cell. Other methods of requesting a cell's value include, using the `get data` command, as well as accessing the `cellValue` property of the cell class. For example:

```
get data cell "Name"
```

Or:

```
cellValue of cell "Name"
```

To retrieve a field value from multiple records at once, you may refer to the field class within the scope of a database itself, rather than a record. For example, the following code will return the value of the *Name* field for every record in the specified database.

```

tell application "FileMaker Pro"
    tell database "Super Heroes"
        field "Name"
    end tell
end tell
-> {"Superman", "Spiderman", "Batman"}

```

Again, in this situation, referring to the document class rather than the database class would allow us to access records within the found subset of records, rather than within the entire database. The following example code will return the value of the *Name* field for every record in the found set of the specified database.

```

tell application "FileMaker Pro"
    tell document "Super Heroes"
        field "Name"
    end tell
end tell
-> {"Superman", "Spiderman"}

```

Fields also have properties, which may be of use to you as you script FileMaker Pro. For calculation fields, a

formula property may be referenced to retrieve the calculation text for the field. For fields that have been assigned a value list, such as the *Powers* field in our sample database, the contents of that value list may be retrieved by referencing the *choices* property of the field. The following code demonstrates how to retrieve a value list for the *Powers* field in our sample database.

```

tell application "FileMaker Pro"
    tell document "Super Heroes"
        choices of field "Powers"
    end tell
end tell
-> {"Flight", "Martial Arts", "Peak Physical Condition", "Spider Sense", "Spider Webbing", "Super Breath", "Super Hearing", "Super Speed", "Super Strength", "X-Ray Vision"}

```

Populating Fields

Now, let's discuss how to populate fields with data. The following example code demonstrates how to set the values of multiple fields within in a given record.

```

tell application "FileMaker Pro"
    set theRecord to create new record at database "Super Heroes"
    tell theRecord
        set cell "Name" to "Batman"
        set cell "Secret Identity" to "Bruce Wayne"
    end tell
end tell

```

AppleScript can also be used to populate container fields with images and other types of data using this same technique. To populate a container field with a file, set the value of the cell to the path of the desired file. For example, the following example code will prompt the user to select a photo of Wonder Woman. It will then create a record for Wonder Woman, populate some text fields, and insert the chosen photo into the *Photo* container field.

```

set thePhotoPath to choose file with prompt "Please select a photo of Wonder Woman:"
tell application "FileMaker Pro"
    set theRecord to create new record at database "Super Heroes"
    tell theRecord
        set cell "Name" to "Wonder Woman"
        set cell "Secret Identity" to "Diana Prince"
        set cell "Photo" to thePhotoPath
    end tell
end tell

```

Working with Records (Part 2)

Now that we have discussed basic record and field interaction, let's return to records again. Two primary tasks that you may want to automate in FileMaker Pro using AppleScript are, performing finds and sorting records.

Finding Records

There are two ways to find records in a database. The first is to make use of the `show` command. The following example code demonstrates how to use this command to find and display all of the records within the specified database.


```

tell application "FileMaker Pro"
  tell database "Super Heroes"
    show every record
  end tell
end tell

```

To find and display records that match certain field values, you can still use the `show` command. However, you must specify the criteria for what you would like to find. This is done using the `whose` clause, and specifying the field you want to search, along with the value you want to locate within that field. For example, the following code will find and display every record in our sample database with a value of *Superman* in the *Name* field.

```

tell application "FileMaker Pro"
  tell database "Super Heroes"
    show (every record whose cell "Name" =
"Superman")
  end tell
end tell

```

A similar code variation can be used to search for records using multiple fields and values. The code below demonstrates this technique. This code will search our sample database for any record with a value of *Superman* in the *Name* field and a value of *Clark Kent* in the *Secret Identity* field.

```

tell application "FileMaker Pro"
  tell database "Super Heroes"
    show (every record whose cell "Name" =
"Superman" and cell "Secret Identity" = "Clark
Kent")
  end tell
end tell

```

Another method of finding records is to make use of FileMaker Pro's find requests. When you perform a find in FileMaker manually, by selecting *Find Mode* from the *View* menu, a new find request is created. You can then enter search values for any desired fields within the request. Additional find requests may also be added, if desired, and even omissions may be specified. This can allow you, for example, to perform a find for every record where field *x* contains a specific value and field *y* does not contain a specific value. See figure 5 for an example of a find request in a FileMaker Pro database.

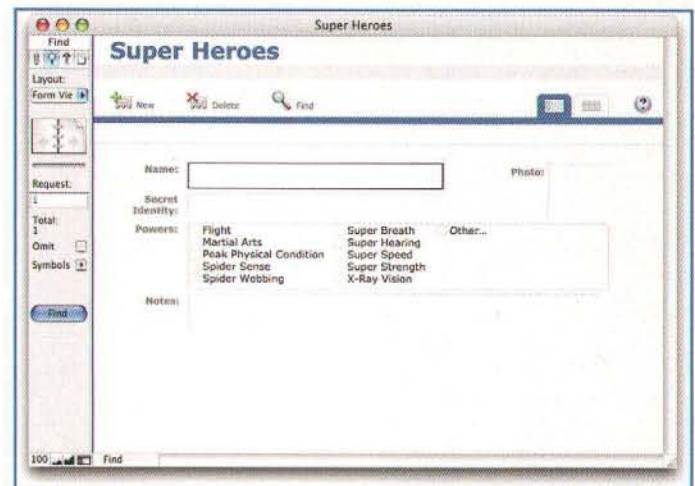


Figure 5. A FileMaker Pro Find Request

Find requests may also be created using AppleScript, and are represented by the `request` class. To create a new find request, use the `create` command. Once a request has been created, much in the same way that you set field values for records, you may specify field values for the fields within find request. Once all field search values have been specified, you may then issue the `find` command to perform a find using any current find requests.

The following code will perform a find by creating a find request. Prior to creating the request, any existing requests will be deleted, ensuring that no previous requests are included in the search. Once this find request has been created, search criteria are specified by setting values for certain fields within the request. Next, the `find` command is issued.

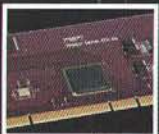
```

tell application "FileMaker Pro"
  tell database "Super Heroes"
    delete every request
    set theFindRequest to create new request
    tell theFindRequest
      set cell "Name" to "Superman"
      set cell "Secret Identity" to "Clark Kent"
    end tell
    find
  end tell
end tell

```

Like performing a find manually, AppleScript can

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create multiple requests prior to issuing a `find` command. The following example code will delete any existing find requests, and create a new request for any records with a value of *Super Strength* specified in the *Powers* field. Next, a second request will be created that will omit any records with a value of *Flight* in the *Powers* field. The `find` command will then be issued. So, in other words, this code will perform a find for any records in the database that have a value of *Super Strength*, but not a value of *Flight* specified in the *Powers* field.

```
tell application "FileMaker Pro"
  tell database "Super Heroes"
    delete every request
    set theFindRequest to create new request
    tell theFindRequest
      set cell "Powers" to {"Super Strength"}
    end tell
    set theFindRequest to create new request
    tell theFindRequest
      set cell "Powers" to {"Flight"}
      set omitted to true
    end tell
  end tell
  find
end tell
```

Using the techniques mentioned above, AppleScript can be used to perform virtually any type of find in FileMaker Pro, regardless of how complex.

Sorting Records

Sorting records is another important task when working with databases in FileMaker Pro. At times, you may want to sort the records within your database, based on data within certain fields. This can be done by using the `sort` command, and specifying the fields and order that you would like to use for sorting. The following code demonstrates the proper syntax for performing a single field ascending sort of our sample database, using the values contained within the *Name* field.

```
tell application "FileMaker Pro"
  tell current layout of document "Super Heroes"
    sort by field "Name" in order ascending
  end tell
end tell
```

To sort the records of a database using multiple sort criteria, the `sort` command may be passed through a list of fields, as well as a list of values for the `in order` property. For example, the following code will sort the database first ascending by the *Name* field, and then descending by the *Secret Identity* field.

```
tell application "FileMaker Pro"
  tell current layout of document "Super Heroes"
    sort by {field "Name", field "Secret Identity"}
    in order {ascending, descending}
  end tell
end tell
```

You may have noticed that the sort examples above, reference the current layout of the document class. FileMaker Pro databases may contain multiple visual layouts, or designs, and the `sort` command requires a reference to a specific layout. Rather than referencing a specific layout by name, the code above simply references the current layout of the document. Please note that, when referencing a layout for sorting, the layout must display the fields that are referenced in the sort.

In Closing

This month's column should give you a basic understanding of scripting FileMaker Pro. While there are other solutions available for data storage and access, FileMaker Pro provides a robust relational database system, along with a very user-friendly visual front end. FileMaker Pro makes it easy to design simple or complex databases, and writing scripts that interact with those databases is fairly easy too.

FileMaker Pro is a frequent choice by many users for storing and accessing data in their automated workflows. Workflows involving FileMaker Pro often include processes such as catalog automation, data archiving, desktop publishing, digital photograph storage and organization, and more. For complex processes such as these, the ability to write AppleScripts to help manage and streamline the workflow is essential, and can allow for great efficiency and processing power.

To further your knowledge of FileMaker Pro, be sure to visit the FileMaker Pro website at <http://www.filemaker.com>. As mentioned earlier in this month's column, a fully functional 30-day trial of FileMaker Pro is available for download from this site. For additional information about AppleScripting FileMaker Pro, check out the *Apple Events Reference* database is installed with FileMaker Pro in the *English Extras > Apple Events* folder.

Until next time, keep scripting!

MM

About The Author



Ben Waldie is the author of the best selling books *"AppleScripting the Finder"* and the *"Mac OS X Technology Guide to Automator"*, available from <http://www.spiderworks.com>. Ben is also president of Automated Workflows, LLC, a company specializing in AppleScript and workflow automation consulting. For years, Ben has developed professional AppleScript-based solutions for businesses including Adobe, Apple, NASA, PC World, and TV Guide. For more information about Ben, please visit <http://www.automatedworkflows.com> or email Ben at applescriptguru@mac.com

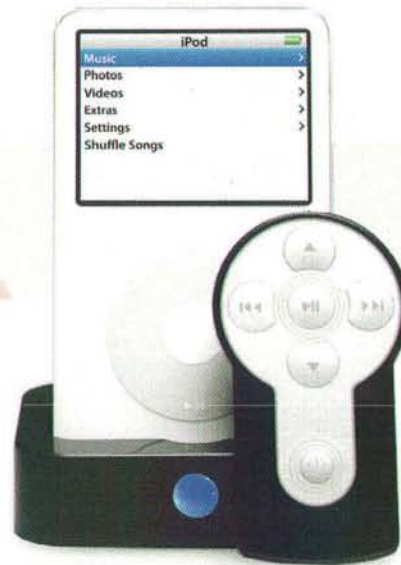
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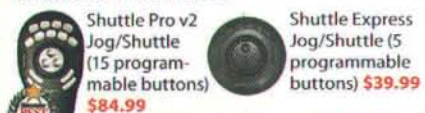


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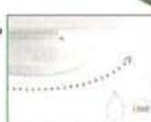
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